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TORPEDO WORK IN THE AMERICAN CIVIL WAR is made the subject of an editorial by the English "Industries and Iron." No less than thirty cases of serious damage or destruction by torpedoes are noted as occurring between December, 1862, and May, 1865. In this list, 24 Federal warships and transports were totally destroyed and 6 others were disabled. The chief cases are given as follows: Armored vessel "Cairo," totally destroyed by submarine mine, December, 1862, in Yazoo River; U. S. monitor "Montauk," damaged by mine in Ogeechee River, in February, 1863; armor-clad "Baron de Kalb," totally destroyed by mine in Yazoo River, July, 1863; armored "New Ironsides" seriously injured by torpedo, off Charleston, October, 1863; sloop-of-war "Housatonic" destroyed by spar-torpedo, off Charleston, Feb., 1864; armor-clad "Eastport" sunk by mine in Red River, May, 1864; Monitor "Tecumseh," destroyed by mine in Mobile Bay, Aug., 1864; gunboat "Otsego," destroyed by mine in Roanoke River; Dec., 1864; monitor "Milwaukee," destroyed by mine in Blakeley River, March, 1865; monitor "Osage," destroyed in same river by drifting torpedo; the gunboats "Aitken," "Randolph" and "Ida" all destroyed by mines in same river, in March and April, 1865; gunboat "Sciota" destroyed by mine in Mobile Bay, April, 1865. The one serious Confederate loss was the blowing up of the ram "Albemarle" by a spar-topedo, by Lieut. Cushing. All of these torpedoes and mines were charged with black powder.

THE HOLLAND SUBMARINE TORPEDO BOAT made a run of 1½ miles under water on April 16, remaining under the surface for 12 minutes. This is the longest run under water which the boat has yet made, and it is stated that she behaved herself very satisfactorily in every respect. It is expected that the formal test of the vessel to be witnessed by a number of naval officers will probably be made sometime this week.

THE ANNULMENT OF LARGE CONTRACTS by the authorities of New York city is likely to take place on account of the recent ruling that in measuring the debt limit of the city, work contracted for but not performed must be included. Under this ruling, the debt of New York city passed the 10% limit some time in 1897, and it is now stated that all contracts awarded subsequent to that date are void. This will stop work on a large number of public improvements.

THE NEW EAST RIVER BRIDGE is involved in the holding up of city appropriations for the present year. Mr. Smith E. Lane, Secretary of the Bridge Commission, in sending a statement of the needs of the commission to the Controller, points out that even temporary suspension of work on the caissons would involve a loss of $250,000, and the stoppage of all work would mean a loss of over $1,000,000 to the city in the protection of work commenced. The city would also run the risk of being liable for large damage claims from the contractors, and the stoppage of payments on these contracts would release the contractors' sureties.

AN IMPORTANT COURT DECISION has recently been rendered in the case of the city of Omaha, Neb., against the Chicago, Burlington & Quincy R. R. Co., in which the city asserted its right to compel this and other railways to construct and maintain viaducts among their tracks wherever it was necessary for the public safety. The railways resisted this contention and the case was brought before the District Court, the Nebraska Supreme Court and the United States Supreme Court in succession, all of which have now decided in favor of the city. Under this decision the city has authority to construct new viaducts or reconstruct old viaducts to carry streets over the railway tracks where the traffic and public safety demands them at the expense of the railway companies whose tracks they cross.

LONDON PUBLIC BUILDINGS, authorized by Parliament at Whitehall and Kensington, will aggregate nearly $16,000,000 in cost. The South Kensington Museum is to be completed, at a cost of about $4,000,000, and the West Kensington Post Savings Bank will add $1,500,000 to this sum. At Whitehall, the Admiralty Building is to be enlarged and finished, a new War Office built on the Covington House site, and new buildings erected for the Board of Trade, Educational Department and Local Government Board. The buildings now occupied for these purposes will be finally vacated and sold, and provide an offset of about $5,000,000 against the expenditures incurred.

THE BRITISH SOUTH AFRICA CO. proposes to expend $7,500,000 in the extension of railways and in other public work. Its annual report, just issued, shows a balance of $2,500,000, and the shareholders will be asked to authorize the issue of ordinary shares to the amount of $7,500,000 for the above purpose. Cecil Rhodes wishes to again become managing director of the company.

A TONKIN-YUNNAN-FU railway concession has been obtained from China by France, says Mr. Hanotaux, French Minister of Foreign Affairs. The Chinese Province of Yunnan, in the southwest corner of the Empire, is very rich in minerals and has an estimated population of 11,000,000. It is a very mountainous region, and railway construction will be costly.

THE FIRST COREAN RAILWAY, 25 miles long, between Chemulpo and Seoul, is being built by Americans. The work includes deep rock cutting, a steel bridge over 2,600 ft. long, over the River Han, and a standard gage railway completely equipped. The Brooks Locomotive Works, of Dunkirk, N. Y., is building the locomotives, and the American Consul-General at Seoul, says that Mr. H. Collbran, of Denver, is the contractor for the railway. The same people have also organized the Seoul Electric Co., made up of Coreans, for building and equipping an electric railway line six miles long. A Russo-Corean Bank has also been established, as a companion institution to the Russo-Chinese Bank, opened two years ago.

A SIX-DAYS' TRANS-SIBERIAN SERVICE, between St. Petersburg and Vladivostock, will be established as soon as the railway is completed, says U. S. Consul Smith, of Moscow. This express train will be only sent out twice in each month. The train will include a dining car, with library, and passenger and sleeping coaches, with all modern improvements.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on April 21 on the St. Louis & San Francisco R.R., about one mile east of Coffeyton, Mo. The accident appears to have resulted from a change of orders and mistake in reading them, which caused a head-end collision between two freight trains. Three men were killed.

A DERAILING SWITCH ACCIDENT at Franklin Park, Ill., was described in our issue of March 10, but we have recently received some official information in regard to the evidence given by the man in charge of the derailed train. It will be remembered that a Wisconsin Central Ry. train was derailed by a derailing switch at a grade crossing, and the engineman and fireman stated that the signal was clear. This, as we stated at the time, appeared to be impossible in view of the fact that the interlocking plant was found to be in proper condition, and we now learn from Mr. Collins, the General Superintendent, that the engineman was engaged in lighting his pipe just as the train was approaching the crossing. Furthermore, as this line is not operated on the block system, the tower man would not know of the approach of the train until the engineman whistled for signals.

A DUST EXPLOSION in the large grain elevator at Hoosac Tunnel docks, Charlestown, Mass., on April 17, blew the roof off and started a fire which destroyed the building and 400,000 bushels of grain in storage. The damage was confined to the building, the stored grain and several neighboring manufactories. Fortunately no one was injured.

20,000 LBS. OF BLACK POWDER in storage at the Miller Powder Works in Sumneytown, Montgomery county, Pa., exploded on April 13. It is reported that the works were completely destroyed and that the shock was felt in Reading, fully 30 miles away.

THE FLOOD IN THE OHIO RIVER, which did so much damage a few weeks ago, is now passing down the Lower Mississippi, and the levees have thus far proved able to hold the water between their lines. While the flood heights in the Ohio were unusually great, the volume of water in the lower river was so small, and the amount of water coming from the Missouri and Upper Mississippi was so moderate that the heights of the flood at Cairo and below were considerably below those of last year. The fact that the Ohio flood had a quick rise and rapid fall also, served to lessen the flood stage in the lower river.

THE DEEPENING OF THE SCHUYLKILL RIVER TO 22 ft. between the mouth and Walnut St. is recommended by Major C. W. Raymond, Engineer Corps, U. S. A. As Walnut St. bridge is without a draw the proposed improvement would stop there, the unobstructed channel being thus only 7.3 miles long. In 1870 there were only 10 ft. of water over the bar at the mouth of the river, with 16 ft. for 4½ miles above. Since 1870 1,690,064 cu. yds. have been dredged from the Schuylkill and deep-draft grain and oil steamers can ascend the river for 4½ miles, to Gibson's Point. The present plan proposes a channel 400 ft. wide on the bottom and 26 ft. deep at mean low tide, from outside the bar to Penrose Ferry bridge, a distance of 1½ miles; a similar channel to Gibson's Point, or 3 miles more; and a channel 320 to 400 ft. bottom width and 22 ft. deep, to Walnut St. bridge. The estimated cost of these three divisions of work is $433,000, $1,140,000 and $1,580,000 respectively, the last division containing considerable rock. Major Raymond recommends the improvement of the lower and middle sections at once, as justified by the commercial interests involved.

IN CONNECTION WITH THE PORT ARTHUR SHIP Canal project, our attention has been called to a news item, in our issue of Feb. 24, credited to the "Kansas City Journal." It was then stated that the Kansas City, Pittsburg & Gulf R. R. "is nominally opposed to the proposed canal." This error was made inadvertently, as we were well aware that the company is not opposed to the canal, but is thoroughly identified with the project. The litigation referred to is merely the ordinary litigation usually arising when railway or canal companies find it necessary to condemn right-of-way. The canal is being built in the interest of this railway company, as stated in our issues of Feb. 17, March 10 and April 14.

THE PANAMA CANAL COMMISSION, sent out by the shareholders to inspect and report upon existing conditions and the practicability of continuing work, has arrived at Colon. The members of this commission are Mr. Choron, Engineer Panama Canal Co.; MM. Etienne and Zurcher, French expert engineers; M. Koch, Engineer of the Kiel ship-canal, and Gen. H. L. Abbot, U. S. Army.

THE UNITED STATES COAST LINE, says the last report of the Coast and Geodetic Survey, has a length of 2,349 miles on the Atlantic Ocean, 1,556 miles on the Gulf of Mexico and 1,810 miles on the Pacific Ocean. The frontage of the country on Canada and Mexico is 4,880 miles in length.

THE NORTHWEST WATER TUNNEL, at Chicago, has again been the source of trouble between the city and the contractors (Weir, McKechney & Co.). The latter applied for an injunction restraining the city from compelling them to alter the grade of the tunnel on Section No. 3, but this has been refused, the court holding that the city had the right to order such a change.

THE NEW WATER-WORKS OF VALPARAISO, CHILI, are described at length in "Le Genie Civil" of March 12, 1898. Briefly stated, these works are as follows: The present population is about 120,000 and the previous daily supply was about 20 gallons per inhabitant. The new supply, authorized in 1880, includes the erection of an earth dam, at Penuelas, 1,607 ft. long on the crest and 46 ft. high, which impounds the rainfall of a water-shed of 24,709 acres and creates an artificial lake of about 4,800 acres. The crest of this great dam is 1,148 ft. above sea level and it is 12 miles from Valparaiso. As the result of 53 years' observation the mean annual rainfall at the city is only about 15 ins.; but it is greater at the site of the dam, or 32½ ins. in 1897, and the authorities figure that they will be able to supply from this source an average of about 27,000,000 gallons per day. Near the dam are located five sand filters; and the aqueduct, which conveys the water to the city reservoir, has 8,528 ft. of tunnel and ten siphons; this aqueduct is partly of beton masonry and partly of cast-iron pipes. The engineer in charge of the work was Mr. Ch. Wargny, and the author of the project was Mr. George Lyon. The works were built by two French contractors, Henri Rabinel and Augustin Marquand.

POWER PLANT WITH ELECTRIC TRANSMISSION AT DELTA, PA.

By S. R. Stubbs,* Member Engineers Club of Philadelphia.

A small electro-hydraulic power plant in York County, Pa., which was visited by the writer during construction, may be sufficiently novel or interesting as a whole, and more particularly as to the natural advantages of the site, and the consequent economy in initial cost of power, to entitle it to a short description in your columns as a type of what can be done at many places more or less favorably situated.

The dam and power house are located at Gartridge Falls, on Muddy Creek, a tributary of the Susquehanna River. The plant was constructed and recently put in operation by the Delta Electric Power Co., of Delta, Pa. Delta is about 5½ miles distant from the falls, and is the center of the well-known Peach Bottom slate quarrying industry. The quarries are on and near the historic "Mason and Dixon's Line," where it approaches the Susquehanna, and their product is generally known by architects and engineers as the highest grade of roofing slate. The principal object sought by the power company is to supplant steam and hand power in the mining and working of slate, the operations in which consist of drilling, pumping, hoisting, sawing, planing, etc., and incidentally to furnish current for lighting in the borough and for small power units there.

Muddy Creek in the last several miles of its course has the features of a semi-mountain stream, and the site selected for the dam is an ideal one for converting hydraulic power at a low cost on the wheel shaft. The stream here flowed through a narrow ravine in a series of falls and rapids over a rocky channel, and at the dam site two opposing rocks on either side of the channel furnished favorable abutments for each end of a short dam, V-shaped in plan, with only 120 ft. length of crest and much less than this at the foot, which is placed at the head of a rocky rapid in the stream. The power house being placed at the foot of this descent in the ravine, gives an available hydraulic head of 42 ft., by the erection of a dam only 30 ft. in height from the rock foundation. In other words, the dam was already partly constructed by nature, leaving an open cross-section of only 3,000 sq. ft. to be closed. The construction is timber crib and rock fill; the crib work sheeted on the upstream side and back-filled with clay and gravel having a slope of about 3 to 1.

The downstream face of the crib work has a slight batter and is left exposed. The thickness at the crest is 15 ft. No spillway is provided, surplus water and floods being intended to pass over the crest, which is roofed with 3½-in. planks, laid ½-in. open to assure the wetting of timbers in the cribs.

*Millville, N. J.

The two-story stone power house in the gulch below the dam is protected from floods by a convenient jutting rock on one side of the channel. The materials of construction for both the dam and power house were close at hand on the wooded and rocky banks of the stream. Thus the cost of the dam was only $4,000, not including the value of timber and stone taken from the land of the company. There was little or no excavation necessary to obtain rock foundation.

An outlet flume 4 ft. in diameter extends through the dam near its bottom. The water is conducted from the dam to the power house by a 7½-ft. steel flume, and reaches the wheels through a 6½-ft. penstock. The estimated available horse-power from the dam and flume, as constructed, is 1,000, about one-half of which is utilized by the present installation of turbines, which consists of a pair of 24-in. McCormick balanced wheels on a horizontal shaft, placed 22 ft. above the tail water. The draft tubes from the wheels are 4 ft. in diameter. The estimated horse-power on the wheel shaft is 550, the plant being designed for an additional pair of wheels when made necessary by future development. The hydraulic machinery was made and installed by S. Morgan Smith & Co., of York, Pa.

The electrical machinery as now installed consists of one two-phase generator of the brushless inductor type, direct connected on the wheel shaft. This is a 350 K-W. dynamo, generating 5,600 volts, which is fed directly into the line through a marble switchboard. The pole line, about 5½ miles long, has four No. 4 bare copper wires on porcelain insulators, triple petticoated. The transmission loss is estimated at 10%. At the slate quarries, step-down transformers will be used to furnish a current of 450 volts for the motors. The same reduction in potential is used for motor current in the borough. The current for lighting the borough will pass through transformers reducing to 1,000 volts on the lighting mains, and again to 110 and 220 volts on the secondary mains. The street lights are incandescent on the 220-volt circuit. The 110-volt current being for house lighting. The electrical installation throughout was made by the Stanley Electric Co., of Pittsfield, Mass.

Current is now being furnished for pumping the borough water supply, street and house lighting, one planing mill motor and a small printing office motor. Wire extensions to the quarries will be made soon. The rate to power takers is $25 per HP.-year of ten-hour days. The plant complete and in operation with one pair of turbines and one generator delivering current to consumers represents an investment of about $30,000. When a larger market has been developed and the additional wheels and generator can be utilized, a much better showing as to first cost per horse-power will be possible. With the plant running at its full capacity the actual cost per horse-power will be very low, and it would appear capable of yielding an unusually good profit to the owners, as well as becoming an important factor in developing the valuable resources of the locality. Westinghouse motors are and will be used for power.

The operating expenses will probably not exceed about $1,500 per annum, and with interest on the above amount of capital added to this, it will be seen at what a low cost per unit of power current can be delivered to consumers when the plant reaches its full capacity.

I am indebted to Mr. C. E. Smith, of York, Pa., and to Mr. J. E. Cutler, of the Stanley Electric Manufacturing Co., for much of the information furnished for this article.

Fig. 1.—Dam During Construction.

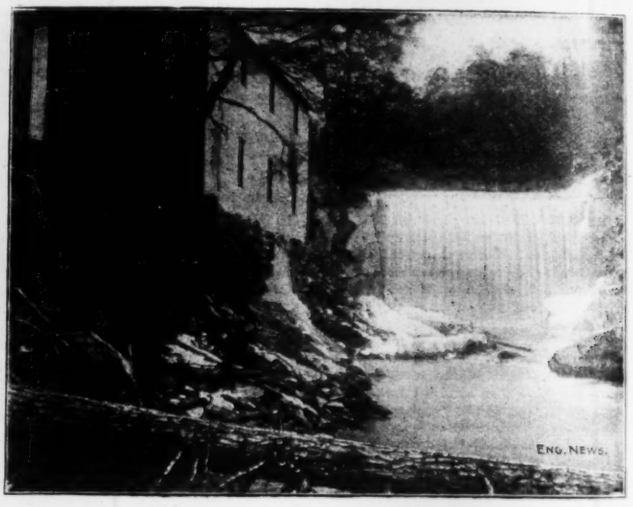


Fig. 2.—Dam and Power-House After Completion.

WATER-POWER PLANT OF THE DELTA ELECTRIC POWER CO., DELTA, PA.

A METHOD OF DETERMINING RAILWAY CROSSING FROG FORMULAS.

By G. B. Zahniser.*

The following method of calculating railway crossing frog formulas may be of too elementary a character to interest some of your readers, but a few years ago after an extended search through the handbooks which were available the writer had to work these formulas out for himself, and it occurred to him that others might have had the same difficulty and would be interested in their publication.

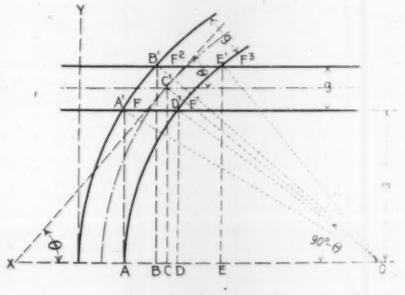


Fig. 1.

Case 1.—To find the frog angles of a crossing when one track on a curve crosses another on a tangent (Fig. 1), having given the radius, the gage and the angle at the center, let

R = radius;
g = gage;
Θ = angle at intersection of center lines, and
F, F¹, F² and F³ = frog angles;
C C¹ = R cos Θ. Then

$$m = \left\{ R \cos \Theta - \frac{g}{2} \right\}$$

$$O D = \sqrt{\left[R - \frac{g}{2} \right]^2 - m^2};$$

*Clendinin Block, New Castle, Pa.

$$O E = \sqrt{\left[R - \frac{g}{2}\right]^2 - (m+g)^2};$$

$$O A = \sqrt{\left[R + \frac{g}{2}\right]^2 - m^2};$$

$$O B = \sqrt{\left[R + \frac{g}{2}\right]^2 - (m+g)^2};$$

$$O A - O D = A D = A' D'. \quad (1)$$

$$O B - O E = B E = B' E'. \quad (2)$$

$$\text{Cos } A' O A = \frac{O A}{\left[R + \frac{g}{2}\right]};$$

$$\text{Cos } D' O D = \frac{O D}{\left[R - \frac{g}{2}\right]};$$

$$\text{Cos } B' O B = \frac{O B}{\left[R + \frac{g}{2}\right]};$$

$$\text{Cos } E' O E = \frac{O E}{\left[R - \frac{g}{2}\right]};$$

$$B' O B - A' O A = \text{arc } A' B'. \quad (3)$$

$$E' O E - D' O D = \text{arc } D' E'. \quad (4)$$

Equations (1), (2), (3) and (4) gave the theoretical distances between frog points. To find frog angles F, F^1, F^2 and F^3, we have the general equations $y^2 = 2 r x - x^2$, and $y = a x + b$. Therefore, to find F,

$$y^2 = 2\left[R + \frac{g}{2}\right] x - x^2, \text{ and } y = m \left\{\begin{matrix} a = o \\ b = m \end{matrix}\right\}.$$

Therefore,

$$m^2 = 2\left[R - \frac{g}{2}\right] x - x^2,$$

and

$$x = \left[R + \frac{g}{2}\right] + \sqrt{\left[R + \frac{g}{2}\right]^2 - m^2}$$

$$\frac{d y}{d x} = \text{tang. } F = \pm \sqrt{\frac{\left[R + \frac{g}{2}\right]^2 - m^2}{m}} =$$

$$\pm \sqrt{\frac{\left[R + \frac{g}{2}\right]^2}{m^2} - 1}. \quad (5)$$

In the same manner

$$\text{Tang. } F^1 = \pm \sqrt{\frac{\left[R - \frac{g}{2}\right]^2}{m^2} - 1}. \quad (6)$$

$$\text{Tang. } F^2 = \pm \sqrt{\frac{\left[R + \frac{g}{2}\right]^2}{(m+g)^2} - 1}. \quad (7)$$

$$\text{Tang. } F^3 = \pm \sqrt{\frac{\left[R - \frac{g}{2}\right]^2}{(m+g)^2} - 1}. \quad (8)$$

Case 2.—To find frog angles of a crossing when one track on a curve crosses two parallel tracks on a tangent (Fig. 2),

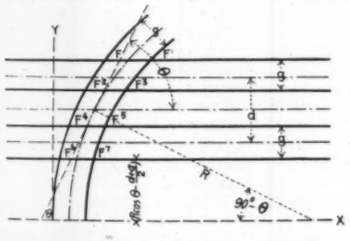


Fig. 2.

having given the radius, gage and angle with the center line between the tracks. Use the same notation as in the previous case, and also let d = distance between centers of parallel tracks. From the general equations

$$y^2 = 2 r x - x^2,$$

and $y = a x + b$ to find F.

$$y^2 = 2\left[R + \frac{g}{2}\right] - x^2, \qquad y = a x + b,$$

$$a^2 = 2\left[R + \frac{g}{2}\right] - x^2, \qquad y = a \left\{\begin{matrix} a = o \\ b = a' \end{matrix}\right.$$

$$x = \left[R + \frac{g}{2}\right] \pm \sqrt{\left[R + \frac{g}{2}\right]^2 - a^2}$$

$$\frac{d y}{d x} = \text{tan. } F =$$

$$\frac{\left[R + \frac{g}{2}\right] - \left[R + \frac{g}{2}\right] \pm \sqrt{\left[R + \frac{g}{2}\right]^2 - a^2}}{a}$$

$$\text{Tan. } F = \pm \frac{\sqrt{\left[R + \frac{g}{2}\right]^2 - a^2}}{a} \quad (1)$$

$$\text{Tan. } F^1 = \pm \frac{\sqrt{\left[R - \frac{g}{2}\right]^2 - a^2}}{a} \quad (2)$$

$$a = R \cos \Theta + \frac{d+g}{2}$$

$$\text{Tan. } F^2 = \pm \frac{\sqrt{\left[R + \frac{g}{2}\right]^2 - b^2}}{b} \quad (3)$$

$$\text{Tan. } F^3 = \pm \frac{\sqrt{\left[R - \frac{g}{2}\right]^2 - b^2}}{b} \quad (4)$$

$$b = R \cos \Theta + \frac{d-g}{2}$$

$$\text{Tan. } F^4 = \pm \frac{\sqrt{\left[R + \frac{g}{2}\right]^2 - c^2}}{c} \quad (5)$$

$$\text{Tan. } F^5 = \pm \frac{\sqrt{\left[R - \frac{g}{2}\right]^2 - c^2}}{c} \quad (6)$$

$$c = R \cos \Theta - \frac{d \cdot g}{2}$$

$$\text{Tan. } F^6 = \pm \frac{\sqrt{\left[R + \frac{g}{2}\right]^2 - f^2}}{f} \quad (7)$$

$$\text{Tan. } F^7 = \pm \frac{\sqrt{\left[R - \frac{g}{2}\right]^2 - f^2}}{f} \quad (8)$$

$$f = R \cos \Theta - \frac{d+g}{2}$$

Case 3.—To find frog angles and distances between frog points when both tracks are curves. Given, radii of both curves, angle at center and gage. Let R and R′ = radii;

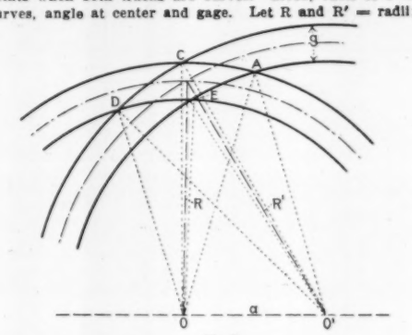


Fig. 3.

Θ = angle between tangents at intersection of center lines; g = gage; O O′ = a. In triangle O H O′ (Fig. 3) we know R − R′ and Θ (included angle) which will give a, thus:

$$\frac{R + R'}{R - R'} = \frac{\text{tan. } \frac{1}{2}(O + O')}{\text{tan. } \frac{1}{2}(O - O')}$$

in which $(O + O') = 180° - \Theta$, and R and R′ are given. Having found O and O′, then

$$\frac{a}{R} = \frac{\text{sin } \Theta}{\text{sin } O'} \text{ or } a = \frac{R \text{ sin } \Theta}{\text{sin } O'}.$$

In triangle A O O′ we know

$$A O' = \left[R' - \frac{g}{2}\right]$$

$$A O = \left[R + \frac{g}{2}\right]$$

and a, therefore we can get angle of frog A from

$$\cos \tfrac{1}{2} A = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - a)}{A O' \ A O}}$$

where $p = a + A O' + A O$.

In the same way

$$\cos \tfrac{1}{2} C = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - a)}{C O' \ C O}}$$

where $p = (a + C O' + C O)$ and

$$C O' = \left[R' + \frac{g}{2}\right] \text{ and } C O = \left[R + \frac{g}{2}\right];$$

$$\cos \tfrac{1}{2} D = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - a)}{D O' \ D O}}$$

where $p = (a + D O' + D O)$ and

$$D O' = \left[R' + \frac{g}{2}\right] \text{ and } D O = \left[R - \frac{g}{2}\right];$$

$$\cos \tfrac{1}{2} E = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - a)}{E O' \ E O}}$$

where $p = a + E O' + E O$ and

$$E O' = \left[R' - \frac{g}{2}\right] \text{ and } E O = \left[R - \frac{g}{2}\right];$$

To find distance between frog points.—Arc A C whose radius is $\left[R + \frac{g}{2}\right]$ measures angle A O C. But angle A O C = O′ O C − angle O′ O A, and O′ O C becomes known from

$$\cos \tfrac{1}{2} (O' O C) = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - C O)}{a \ . \ O C}}$$

where $p = a + C O' + C O$ and

$$C O' = \left[R' + \frac{g}{2}\right] \text{ and } C O = \left[R + \frac{g}{2}\right]$$

$$\cos \tfrac{1}{2} (O' O A) = \sqrt{\frac{\frac{1}{2} p (\frac{1}{2} p - A O')}{A \ . \ A O}}$$

where $p = a + A O' + A O'$, and

$$A O' = \left[R' - \frac{g}{2}\right] \text{ and } A O = \left[R + \frac{g}{2}\right]$$

In same manner we can find arcs C D, D E and E A.

SIMPLE AND ACCURATE RULES FOR THE COMPUTATION OF SHORTENED SWITCH LEADS.

By Wellington B. Lee, Assoc. M. Am. Soc. C. E.*

In furnishing instructions for the computation of switch leads, it will be well to begin with the frogs and switches themselves to correct such erroneous ideas as are prevalent and bring out some points often unapparent to trackmen. In all cases where spread is mentioned in this article it is understood to be between gage lines.

The number of any frog is the ratio between the distance, on the gage line, of any point from the vertex and the spread at that point. This makes the number equal to the reciprocal of twice the sine of half the frog angle. Particular attention is called to the fact that the distance from the vertex is measured on the gage line, this being the established custom among manufacturers, while the majority of engineers' pocket-books measure along the center line which gives tangent instead of sine. To measure along the gage line is the more rational method, as here we have something definite; it gives the distance from vertex to heel and toe on the gage line as exact products of their respective spreads by the frog number, and not slight fractions in excess; for the rail follows the gage line, and it is the rail that has to be cut and worked in making a frog. The actual point is situated back of the vertex a distance equal to the product of its width by the frog number. Most frog points are ½-in. wide.

Unless the point of a switch is planed to a knife edge the vertex is some distance ahead of the actual point, a common width being ⅜-in. Here, at the vertex, the bend in the stock rail should be made, approaching a sharp kink as closely as possible. If the width of point be subtracted from the spread at the heel and the length of switch divided

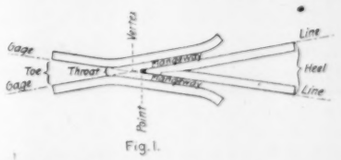


Fig. 1.

by this difference, we have a result which we may call the switch number, representing the angle of the switch in exactly the same manner that the frog number represents the frog angle. The introduction of this new function, as will be seen later on, enables us to reduce the present tedious formulas for computing shortened leads to very much simpler forms.

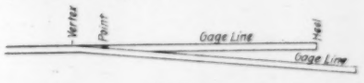


Fig. 2.

It is apparent that the distance from the vertex to the switch point equals the width of the point multiplied by the switch number.

With a given switch and frog there is but one radius for the arc of a circle which will connect the heel of switch and toe of frog and be tangent

*Hillburn, Rockland County, N. Y.

at those points, and it is also the maximum, as will be seen from the diagram; for if we move the switch toward the frog, we shorten the tangent distance T next the switch, and just as surely if we move the switch away from the frog we shorten the tangent distance T_1 next the frog. This has already been ably expressed by Mr. Torrey in his book on Switch Leads, but will bear reiteration here.

It has been stated by one writer on turnouts that for straight switch rails we could use the more simple rules for curved switch rails, and be mathematically accurate by considering the turnout as a parabola. This is a very neat and self-satisfying assumption, a tempting morsel thrown to our complaining conscience, but, nevertheless, there will be some portion of that parabola whose radius of curvature will be less than that of the maximum circular curve.

To compute the leads a and b, and the radius R by exact methods, requires the use of trigonometrical functions, and preferably a table of logarithms, so the writer in preparing this article has developed a set of arithmetical formulas which give surprisingly accurate results. With a No. 4 frog the error in leads is but 1 in., and in radius 6 ins. This error decreases as the frog number increases,

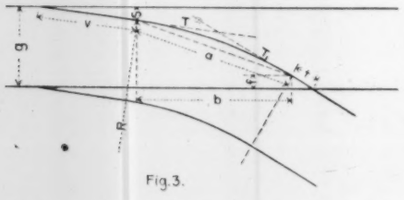


Fig. 3.

until with a No. 10 frog it is but 1-16-in. in leads and 1¾ ins. in radius.

There is generally given, gage of track, g; vertex to heel of switch, v; spread at heel of switch, s; vertex to toe of frog, t; spread at toe of frog, f. Then,

$$\text{Switch number, } n = \frac{v}{s},$$

$$\text{Frog number, } N = \frac{t}{f},$$

$$d = g - (s + f).$$

$$a = 2\,d\,\frac{n\,N}{n + N}.$$

$$b = \sqrt{a^2 - d^2}$$

$$R = a\,\frac{n\,N}{n - N}.$$

Expressed as rules these formulas would be as follows:

To find the lead from toe of frog to heel of switch rail on opposite sides of main track; subtract the sum of the spreads at heel of switch and toe of frog from gage of track and multiply by two; multiply this result by the product of the switch and frog numbers and divide by their sum.

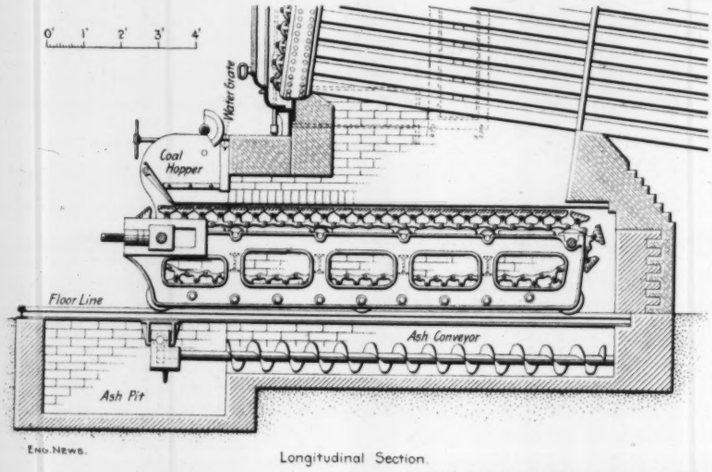
To find the lead from toe of frog to heel of switch rail on same side of main track, subtract the sum of the spreads at heel of switch and toe of frog from gage of track and square the result; subtract this from the square of lead found above and extract the square root.

To find the radius of outer rail, multiply the lead first found by the product of the switch and frog members and divide by the difference.

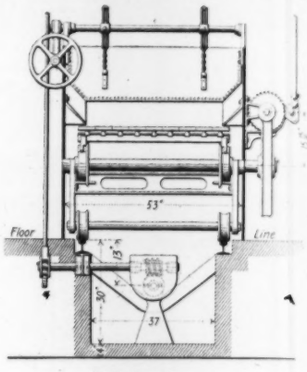
With these simple rules at hand there should be no further occasion for putting in "shortened leads" by rule of thumb or methods patched up from the old rules for "long leads."

TEST OF A CHAIN GRATE STOKER WITH KANSAS COAL.

We have received a copy of the record of a boiler test made at the Kansas City, Mo., waterworks, on a "National" water tube boiler, equipped with a Playford chain grate stoker, and using



Longitudinal Section.



End Elevation.

THE PLAYFORD CHAIN GRATE STOKER.
Made by the Playford Stoker Co., Cleveland, O.

Cherokee, Kansas, slack coal. We give the record in an abridged form below.

The stoker, made by the Playford Stoker Co., of Cleveland, O., is shown in the accompanying cuts. It is of the chain grate type, and consists of an endless grate supported upon a carriage mounted upon wheels, standing on iron rails and easily removable from underneath the boiler. The grate consists of chains, wrought iron T-irons, and small grate bar sections. The T-irons are fastened to opposite links of the chains, and over them slide the small sectional bars. The coal is delivered into the traveling grate from a hopper. A water front is provided to the stoker which prevents the coal in the hopper from igniting. An ash conveyor is placed under the grate to carry the ashes that fall over the rear of the grate to the ash pit in front of the boiler.

Two of these stokers were installed in the Kansas City water-works in July, 1897, and they have been in daily use ever since. The condensed record of the test is as follows:

Test of Water Tube Boilers Erected at the Kansas City, Mo., Water-Works by the National Water Tube Boiler Co., New Brunswick, N. J., Equipped with the Playford Stoker. Test made by W. Kiersted, Chief Engineer of the Water Department.

Date of trial	Jan. 19, 1898.
Duration of trial	8 hrs.
Water heating surface	3,024 "
Grate surface	52 sq. ft.
Steam pressure in boiler by gage	80.2 lbs.
Temperature of escaping gases	401° F.
Temperature of feed water	39° F.
Fuel, Cherokee slack, mined in Kansas; total amount of coal consumed	13,294 lbs.
Moisture in coal	3½%
Total refuse, dry, 1,919 lbs. =	14.43%
Total water evaporated	91,962 lbs.
Water evaporated:	
Actual conditions, per lb. of moist coal	6.92 "
Equivalent water evaporated:	
Into steam, from and at 212° F., per hour	13,971 "
Per lb. of moist coal, from and at 212° F.	8.41 "
Per lb. of dry coal, from and at 212° F.	8.71 "
From and at 212° F., per lb. of combustible	10.25 "
Per hr., from and at 212° F., per sq. ft. heating surf.	4 "
Coal burned, per sq. ft. of grate surface, per hour	32 "
Commercial horse-power	
Per cent. above rating of 300 HP.	
Efficiency of boiler	3
Exceeds the contract requirement by	
Rate of evap. per hr. exceeds contract requirement for average work of boiler	

The "efficiency" of 74% is based on an assumed value of 11,000 B. T. U. as the average heating value per lb. of Cherokee slack. The guaranteed efficiency was 65%. The reported moisture in the coal, 3½%, is probably much less than the actual. Other samples weighed after the test showed 5.66% moisture.

NOTES FROM AMERICAN BRIDGE SHOPS.

V.

Youngstown Bridge Co., Youngstown, O.—As some of the readers of Engineering News may remember, the old shops of this company, after being in operation nearly ten years, were destroyed by fire in September last. This accident, of course, necessitated the company building an entire new plant and it improved the opportunity to rearrange its buildings and machinery in conformity with modern ideas of shop construction and equipment. The new buildings consist of a main truss shop 80 ft. wide and 500 ft. long, with two wings 26 × 100 ft., into which run the loading and unloading tracks, and a combined forge shop, machine shop and power house, 60 ft. wide and 180 ft. long. These buildings have steel frame work with walls of rock-faced, clay tile and concrete floors. At the time of the writer's visit both buildings were practically completed except for the concrete floors, and some of the finishing and many of the tools had been installed and were in operation.

All material enters the main truss shop by means of a railway track running lengthwise of the 26 × 100-ft. wing, and in the shop proper it is handled by trolleys running on the chords of the roof trusses, by an overhead runway and by push cars. The overhead runway and push cars run lengthwise of the shop, and the trolleys crosswise, and the axles of the runway carriages, trolleys and push cars all have roller bearings. From the cars at the unloading track the material passes to the laying-out skids, shears, punches, reamers, drills, riveters, and finally to the painting skids at the opposite end of the shop. From the painting skids the finished material is loaded into railway cars entering the second 26 × 100-ft. wing on a depressed track.

All machines are driven by electric power, the motors being arranged so as to operate groups of machines. This arrangement was adopted in order to utilize the old tools which the company had, rather than as a matter of preference. The dynamo supplying power to these motors is located in the machine shop, as are also the engine and four air compressors. About the center of the 60 × 180-ft. building, and between the machine shop and forge shop is located the boiler room. The machine shop tools are operated by a countershaft direct from the engine, but the template shop tools like those of the main truss shop, are run by electric motors.

While the foregoing gives roughly the construction and arrangement of the new shops, it fails utterly, as any brief description must, to give the reader an idea of their light, roomy appearance,

which is in striking contrast to the bridge shops built twenty or thirty years ago. In heating, as well as in lighting and ventilation, the comparison is almost as striking, the main truss shop being heated by a Sturtevant blower system using exhaust steam from the power house.

The endeavor to reduce friction in the hoisting and conveying machinery by roller bearings has already been mentioned. It should be noted in addition that the more common wooden skids have been replaced by iron skids, consisting of railway rails supported by cast-iron pedestals with slotted tops to clamp the rail base. Each pedestal is carried by a concrete foundation. Another convenient arrangement worthy of notice was the location of the rivet machines and rivet heating forges side by side, with iron bins for storing the rivets between, thus avoiding unnecessary transportation of the rivets and enabling them to be used, one might say, hot from the machines. Still another noticeable detail was seen in the compressed air piping system which was designed with long radius bends instead of elbows to reduce friction and loss of power.

Wrought Iron Bridge Co., Canton, O.—The shops of this company are comparatively new, having been built in 1892, and impress the visitor very favorably, being well lit and spacious, and having a well-arranged equipment. The main building covers a square 256 × 256 ft., of which the first 31 ft. on the north side is divided into a Superintendent's office, tool room and packing room, 32 ft. long each, and a template shop and small tool machine shop, each 80 ft. long. Of the remainder all but 170 × 64 ft. of the southeast end, nearly all of which is used as a forge shop, is used as the main riveting shop. This main shop is so constructed as to have but four interior columns, while each line of trusses, 16 ft. apart, is built with the lower chord fitted for trolleys, having a clear travel, except on the four column lines, of 225 ft. across the entire shop.

Three railway tracks enter the yards at the northeast corner, two of which pass into the main shop just inside the north and south walls, respectively, while the third enters the stock house just east of the main building. The material for built-up members is conveyed into the main shop on the north switch track, unloaded on the adjacent skids, and is there laid out for the punches and shears. From the punches and shears the material passes to the straightening machines and curving rolls, thence to the assembling skids, reamers, riveters, planers, fitters, drills and painting-skids adjacent to the loading switch entering the south side of the shop on a track depressed 4 ft. below the floor. The several operations through which the material passes have the machinery for them arranged in lines extending east and west across the building, so that the material takes a more or less zig-zag course across the building from north to south. The painting and unloading skids occupy a strip 14 ft. wide across the building from east to west, giving plenty of room for ordinary conditions, but to provide for extra storage and unloading space the depressed track is continued outside of the building on the west side. Eight lines of push car tracks pass through the building from east to west and connect it with the store house, storage skids and yards. Movement across the building from north to south is by means of the trolleys previously mentioned.

These trolleys are of 10 tons capacity each, have roller bearings and run on half-round tracks. The riveters are hung from carriages working on an overhead runway traversing the building from east to west, and it may be noted here that in order to pass easily the gaps made in the runway tracks for the passage of the trolleys, the runway carriages have three wheels on each side. In connection with this plant of compression riveters the writer noticed a home-made, impact, cold riveting machine which gave every indication of being a very handy tool for light work. This machine was set up much like an ordinary single punch, the hammer head being above and the anvil below, with a table on each side of the throat. These tables were capable of adjustment both vertically and sidewise, while the anvil could be dropped below the bed plate by a foot lever in order not to hinder the longitudinal movement of the work. The hammer head itself was simply an ordinary construction pneumatic hammer.

For its reamer work this company use a plant of eleven Ross reamers, this being the largest plant, and, so far as the writer knows, the only plant of these tools, except one, in use in this country. A pretty clear idea of these reamers may be obtained from Fig. 1. At S is a line shaft extending from east to west across the shop which runs continuously and carries one or more yokes in which it turns loosely, and from which the machines are supported. The miter gear wheel A is engaged by the sleeve, which is feathered on the shaft and is engaged or disengaged with the miter wheel A by the lever B, operated by the handles C, C. The illustration shows the gear engaged. This gear drives a short shaft D, which, through a knuckle joint, F, operates a suspended sleeve E through a square hole bushing, in the bottom of which the shaft G slides up and down and is sustained by the friction and balance counterweight W, which travels on the guide bar H H and is suspended by chains I I. The foot of the shaft G terminates in a second knuckle joint J, which gives play to the tool T, K K being the handles for directing the tool. At these shops each reamer has a travel of 10 ft. along the shaft.

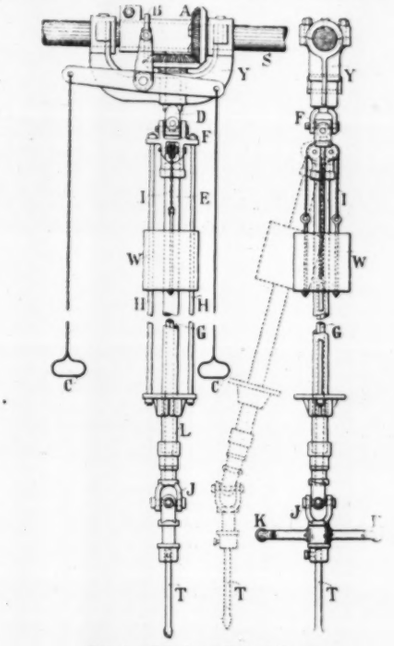


Fig. 1.—The Ross Patent Reamer Wrought Iron Bridge Co., Canton, O.

A distinctive feature of this plant for a long time was the use of electric power for operating its machinery, but now other shops have adopted the same power quite as extensively, leaving to this company simply the distinction of being the originator. From the power house the electricity is conveyed to motors placed at different points in the main building, each motor operating one or more machines, as circumstances require.

King Bridge Co., Cleveland, O.—These works well deserve the claim of their owners to be among the most modern and complete bridge shops in the country. They consist of a template shop, rivet shop, forge and eyebar shop, blacksmith shop, machine shop, loading and painting shop, and a number of smaller buildings. The offices and drawing rooms are housed in a separate three-story brick building close to the main shop buildings, and a visit to the drawing rooms brought out several items of general interest.

All drawings are made on sheets 24 × 35 ins., and generally about six blue prints are made from each drawing. Every drawing is made complete in all respects, the template shape not being depended upon for any part of the work except in occasional instances. A rather elaborate system is used for numbering drawings. First of all the drawings are numbered by spans and years, the number 75-1898, for example, meaning span No. 75 of the year 1898. This is what may be called the shop number and by it the drawings are indexed and filed. Besides this shop number each sheet has a subsidiary numbering, thus 2-11, 3-11, meaning sheet No. 2 of 11 sheets, sheet No. 3 of 11 sheets, the final number, which, in this example, is No. 11, indicating that there are eleven sheets of drawings in the job. The drawings for each job are rolled and filed in pigeon holes. For the current year's work a case having pigeon holes about 2 × 2 ins. in the clear is used, a single set of drawings being filed in each compartment. At the end of the year this case is emptied for the new year's work, the drawings being rolled together in larger rolls and filed in another case having pigeon holes about 4 × 4 ins. in the clear. The correspondence, specifications, approved drawings, etc., for each job are filed in the ordinary letter files in the same fireproof vault containing the cases for drawings.

The railway tracks enter the main or rivet shop, the loading and paint shop and the forge shop, as well as the main unloading yard of the works. In the unloading yard these tracks pass under a frame work consisting of three parallel trusses supported on columns. The bottom chords of these trusses carry trolleys from which are suspended air hoists, which lift the material off the cars and store it, except when it passes directly into the shops. All loading is done under cover in a building 100 × 176 ft. Finished material enters this building from the other shops on push cars which travel lengthwise of it. Air hoists mounted on trolleys traveling on the bottom chords of the roof trusses lift the material from the cars and transport it in a transverse direction. The railway track entering this building is depressed below the floor level, and the air hoists bring the material to it from the painting skids and push cars.

The rivet or truss shop is "double;" that is, the machinery on each side of the longitudinal axis is in duplicate, and two jobs can be put through the building at one time practically independent of each other. Push cars provide longitudinal movement, while all transverse movement is by air hoists suspended from trolleys, as in the shipping and painting shop. The reamers and riveters occupy the space next to the walls on each side, the latter tools being suspended from the carriages of an overhead runway. Between these are located the other tools, which are in duplicate, as before stated, on each side of the longitudinal axis of the shop.

The blacksmith, forge and machine shops are in a single building running parallel to the rivet shop. The railway tracks enter the forge shop, which is equipped with the usual small tools and with hammers and upsetting machines for manufacturing eye-bars up to 26 ins. heads. The machine shop is equipped with a Bement-Miles double boring machine, having an adjustment of the tool heads varying from 2½ ft. to 50 ft., and designed to bore both ends of an eye-bar at once. Another machine which the writer noticed in the machine shop was a device for assembling swing bridge turntable drums. Just over a heavy wooden floor supported on concrete foundations, a circular track girder was suspended from the roof trusses. At the center of this circular track was a vertical pivot. To this was pivoted a radial arm having at its opposite end a wheel which ran on the circular track girder; that is, the arm could be swung radially around the pivot in a horizontal circle. Mounted on this radial arm was a trolley from which hung an air hoist. This hoist, it will be seen, by virtue of its travel along the radial arm and the revolution of the arm itself, covers every point of the circular area occupied by the drum which is being assembled.

Variety Iron Works Co., Cleveland, O.—As the name of these works indicates they handle a variety of foundry, machine, tank and structural work rather than bridge and building alone, as do most of the other shops which have been mentioned in these notes. At the time of the writer's visit, however, they were principally occupied with heavy castings and tank work for beet sugar refineries. Among other recent heavy productions of the company's foundry were noticed a series of eleven cast-iron cylinders for the intake of the new water-works tunnel at Cleveland, O. Fig. 2 is a view of one of these castings, each of which is 11 ft. in diameter and 9 ft. long, with a shell 2½ ins

thick, and a flange cast on each end. The writer's inquiry as to the nature of the methods adopted and special precautions taken to insure the successful production of these large cylinders brought

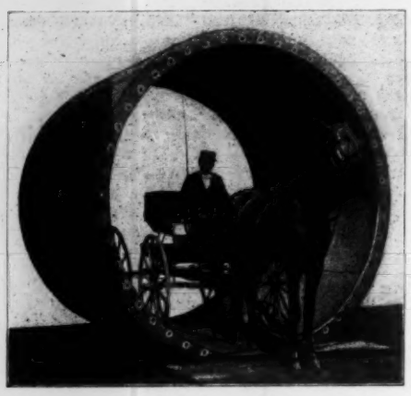


Fig. 2. Cast Iron Cylinder, 11 ft. in Diameter, for Cleveland, O., Water-Works Tunnel.
Variety Iron Works Co., Cleveland, O.

the reply that "it is a Yankee trick which we are not telling."

For heavy tank work the company has an unusually complete equipment of tools. One of the larger tools which indicates especially well the heavy character of some of this tank work is a special riveter. This riveter is set vertical; that is, with the jaws projecting upward like a letter U, in a square, tower-like building. At the top of this tower is a carriage carrying powerful hoisting machinery for handling the cylindrical tank sections, which may be of any depth up to 12 ft., the throat of the riveter being 12 ft. deep; or, by reversing the work once, a section 24 ft. long may be riveted. This riveter is operated by hydraulic power.

Massillon Bridge Co., Massillon, O.—These works were found quite busy on the steelwork for the new station and trainshed of the Cleveland Terminal & Valley R. R., at Cleveland, O. In this station the tracks enter the trainshed at the second story, and the floor framing carrying the tracks is correspondingly heavy. A switch track enters the unloading yard of the works, passes along one side and enters the girder shop by a depressed track. The side of the yard opposite the switch track is bounded by the machine and forge shop building, and a bridge crane runs lengthwise of the yard, covering its entire width, including the switch track. Push car tracks from the unloading yard take the material into the buildings.

In the girder shop only riveted work is done, and here is the usual equipment of punches, riveters and lay-out and assembling skids. Among the special devices employed in this shop the writer noticed a gang of four 11-ton air hoists mounted on overhead trolleys, which it was stated had proved especially useful tools for shifting and turning heavy girders. The forge shop is fitted with the usual machinery for iron eye-bar manufacture and clevis and hanger work. No steel eye-bar work is done.

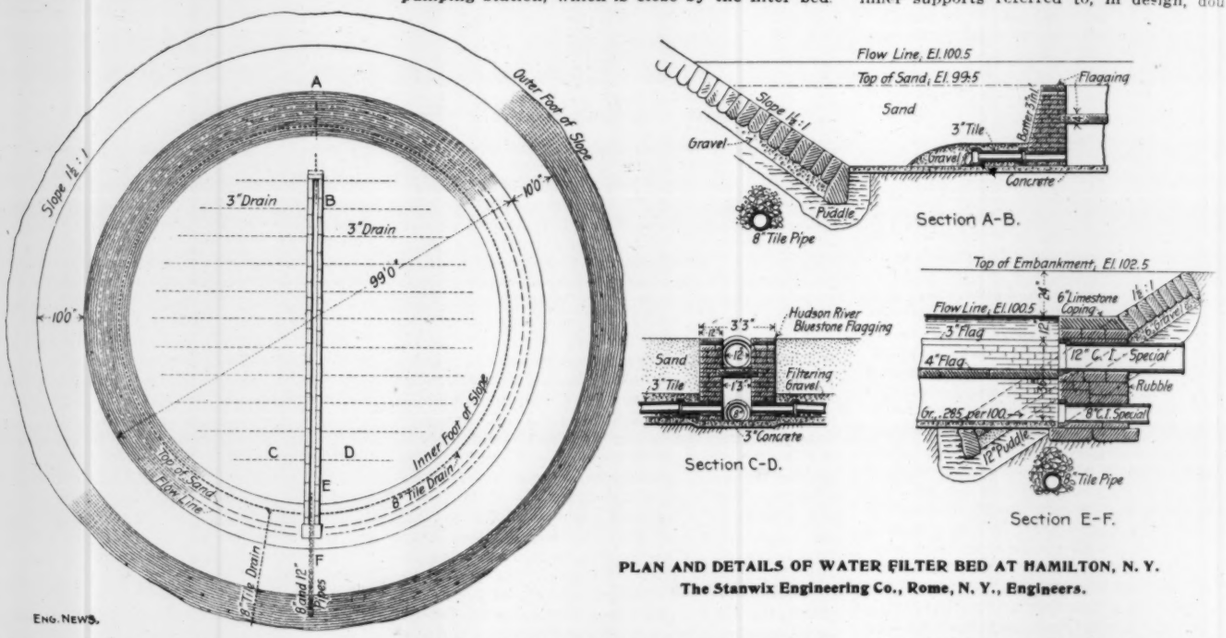
A SMALL WATER FILTER BED AT HAMILTON, N. Y.

Several small places have installed filter beds as a part of their new water-works systems of late. Among these places is Hamilton, N. Y., which introduced a public water supply in 1895. Water for these works is brought from the outlet of Woodman's Pond, or Spring Lake, through a combined 18 and 15-in. tile conduit about 1¾ miles long. The head of the conduit is but a few feet above the water level in the filter.

The general characteristics and dimensions of the filter bed are shown by the accompanying illustrations. The bed is circular in plan, with a surface area of about one-eighth of an acre. It was designed to give a capacity of 500,000 gallons an acre a day, when working under a head of 1 ft. This is double the estimated consumption for some years to come.

Water is admitted to the bed through a masonry carrier, as shown in the illustration, beneath which is the main underdrain. The valves controlling the operation of the filter are all in the pumping station, which is close by the filter bed. The water can be delivered to the pumps without filtration, if desired. Provision is made for reversing the direction of the flow through the filter for cleaning, the waste water passing off at the top through a 12-in. cast-iron waste pipe.

The contract price for the filter bed, exclusive of land, engineering, pipe, specials, valves, and their setting, was $3,150. The plant has been in operation more than two years. The engineer for the water-works, including the filter, were the Stanwix Engineering Co., of Rome, N. Y., to whom we are indebted for this information.



PLAN AND DETAILS OF WATER FILTER BED AT HAMILTON, N. Y.
The Stanwix Engineering Co., Rome, N. Y., Engineers.

THE BRIDGE OF ALEXANDER III., AT PARIS.

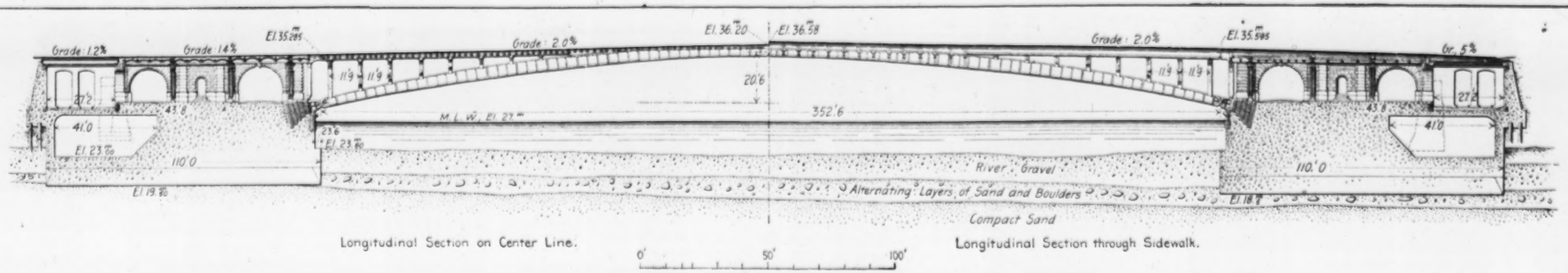
(With full-page plate.)

One of the features of the coming Paris Exposition of 1900, will be a structure which will form a permanent and handsome addition to the bridges now crossing the Seine in that city. This bridge has been named the bridge of Alexander III., in honor of the Czar of Russia. Its foundations are now practically completed. Aside from its great width and the extreme flatness of its arch, there are a few novel engineering features in this structure, and these are chiefly in the abutment foundations.

The bridge proper is a three-hinged arch of mild steel, 352.6 ft. span between centers of abutment hinges, and with a rise of 20.6 ft. between centers of crown and abutment hinges. The roadway is wider than that of any other Paris bridge, being 40 m., or 131.2 ft.

The bridge crosses the river at an angle of 82° 38', and owing to its great width the caissons upon which the abutments are founded are of unusual size. In plan they form parallelograms. Each caisson is 145.2 ft. wide, measured across the bridge, and 106 ft. long. The bottom material is mud, gravel and alternate strata of sand and bowlders; and in the latter the cutting edge of the caisson rests at a depth of 18 ft. below the bed of the river, or 29 ft. below ordinary water level. Owing to the extended area of roof to be supported, the working chamber of the caisson is divided into five great communicating compartments, each 145 ft. long, by four lines of interior supports, spaced 31.5 ft. apart. The surface area of each caisson is 15,860 sq. ft. The working chamber, or caisson proper, is 6.23 ft. high in the clear and is surmounted by a roof of latticed girders 5.21 ft. deep; a ceiling of steel plates being riveted to the under side of the upper chord of this girder. The exterior of the caisson is made of plates and cover-plates, 6 mm. thick, the plates being 6.23 ft. high and 3.93 ft. wide. The exterior sides of the working chamber are braced as shown and filled with beton, and the bottom or cutting edge is formed of angles and a plate 18 mm. thick. The four lines of inner supports referred to, in design, double the outer cutting edge; and with the outer lines these support the roof made up of two systems of latticed trusses, firmly riveted and braced together. The first system is formed of the four main trusses noted, and the second system includes 27 cross girders, spaced 6.3 ft. apart, at right angles to the first. Above the roof the sides of the working chamber are made of metal plates, 4 mm. thick for a height of 5 ft. and 3 mm. thick above that. These are braced and strengthened by flanges, and they are made so as to be removed on the river face, or exposed part of the abutment.

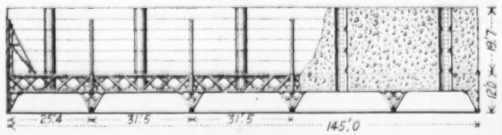
Each caisson is surmounted by ten air-lock shafts or two to each great compartment of the working chamber. The cylindrical shaft has an interior diameter of about 36 ins., and a height above the caisson proper of about 50 ft. Owing to this height it was necessary to support them with strong timber scaffolding, carrying a working floor upon which were placed the narrow railways used in conveying away the material excavated and bringing in the beton finally used in filling the caisson. The dimensions and details of the air-locks are not



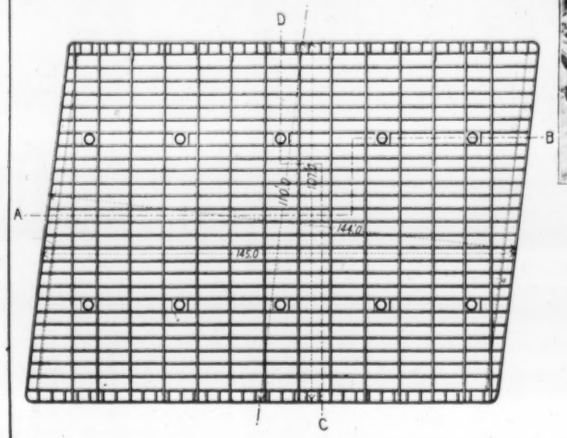
Longitudinal Section on Center Line.

Longitudinal Section through Sidewalk.

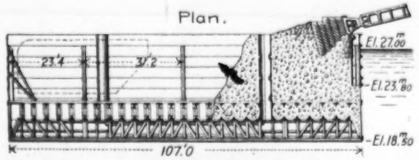
FIG. 1. SECTIONAL ELEVATIONS.



Transverse Section A-B.



Plan.



Longitudinal Section C-D.

FIG. 2.
PLAN AND SECTIONS
OF PNEUMATIC CAISSONS.

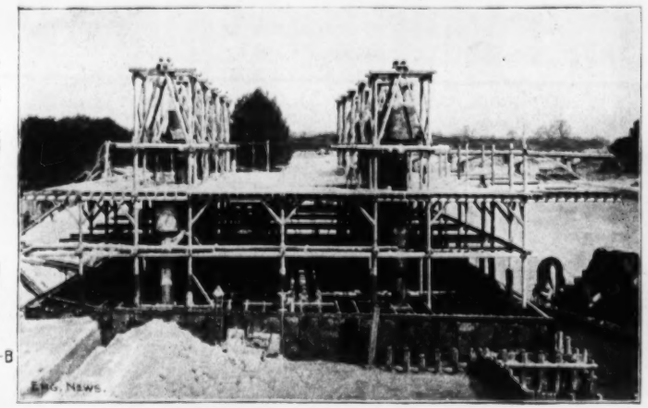


FIG. 4. CAISSON FRAMED; AIR-LOCKS AND WORKING PLATFORM IN PLACE; AUG. 3, 1897.

FIG. 5. CAISSON SUNK TO FINAL LEVEL, 27 FT. BELOW ORDINARY WATER LEVEL; OCT. 31, 1897.

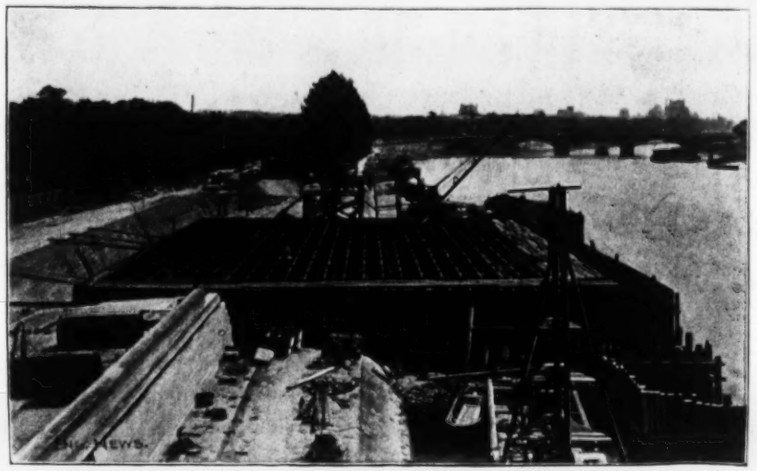


FIG. 3. FRAMING OF CAISSON; SHOWING CONDITION ON JUNE 26, 1897, WITH CUTTING EDGE AT WATER LEVEL.

THE BRIDGE OF ALEXANDER III. AT PARIS, FRANCE.

M. Alby, Engineer in Charge of Construction.

Letellier & Boutrinquin, Contractors for Foundations and Masonry.

given; but the photographic views show that each had a side door, and two chutes for discharging material in the bottom.

It should have been mentioned that the foundation soil, on the right bank of the river, included a trench once occupied by an old wall and filled up, and at the river edge of the caisson the bed of the river sloped so rapidly that the caisson had first to sink through about 17 ft. of water before the cutting edge met the natural soil. Owing to this conformation piles were first driven into the river-bed, outside of the caisson, and from a truss supported by these piles, timbers were run into the solid ground, just above the water level. The building of the caisson was started upon this combined natural and artificial support, until the framing was sufficiently advanced to permit the removal of the timbers. After that, as the sinking of the caisson progressed, the interior of the working chamber was in free communication with the water for some time, and a considerable part of the material removed from the inner area of the caisson was dumped into the water at the front edge and lifted up again by dredgers. This proceeding was not very economical; and on the left bank the ground above the water level was sufficient in area to include the whole caisson, and the lines of piles and their accessories were not required.

The official elevation of the bridge and the photographic progress views here presented were obtained directly from M. Alby, the Resident Engineer in charge, through the courtesy of Mr. E. La Manna, C. E., of New York city. In a letter of Nov. 24, 1897, Mr. Alby says that the cutting edges of the caisson on the right bank had then reached a soil made up of calcareous rock, more or less hard, and perfectly resisting. The compressed air was applied on Aug. 20; the bottom was reached Oct. 23; from Oct. 25 to Nov. 7 the working chamber was being filled with concrete, and the pressure was let off on Nov. 9. In this interval (of 64 days, Aug. 20 to Oct. 23), the cassion descended 23.3 ft., an average sinking of a little over 4 ins. per day. The total time elapsing between the beginning of sinking and the sealing of the working chamber was 81 days. The caisson, by its own weight, had sunk down 3.77 ft. below the water level, so the total distance actually sunk was about 27 ft. below ordinary water level.

On Oct. 23, the total weight of the caisson was 18,423 metric tons; deducting the lifting power of the compressed air, the effective weight was 5,894 metric tons. On Aug. 20, the total weight was 2,873 tons, and the effective pressure only 1,100 tons. A delay of about 15 days was occasioned by working through 17 ft. of old pier wall foundation; and about 300 pieces of oak belonging to these foundations had to be removed from under the cutting edges of the caisson.

The contractors for the caisson work are Messrs. Dayde & Pille, who sublet it from Messrs. Letellier & Boutrinquin, who have the contract for the masonry of the bridge.

SOME LETTERS OF ROBERT FULTON CONCERNING THE ENGINES FOR HIS FIRST STEAMBOAT.

At the recent meeting of the British Institution of Naval Architects, March 31, a paper was presented by Mr. Charles H. Haswell, the veteran American engineer, entitled "Reminiscences of Early Marine Steam-Engine Construction and Steam Navigation in the United States of America from 1807 to 1850."

In connection with the discussion of the paper Sir Frederick Bramwell sent a letter enclosing some original documents by Mr. Robert Fulton which had been loaned him by Mr. George Tangye of Soho. These were three letters from Mr. Fulton to Boulton & Watt. The first was dated Manchester, November 4, 1794, asking the price of a three or four HP. engine to be placed in the boat. The next was dated August 6, 1803, in which he ordered parts of an engine to be built according to a drawing of the same date. The last was dated July 28, 1804, referring to the condenser of the engine. The engine parts referred to were built by Boulton & Watt and shipped to the United States in 1806, and used in Fulton's famous steamboat, the "Clermont," which made its first trip in 1807 on the Hudson. The letters were published in "Engineering" of April 8, and we reprint them below:

WEATHER TABLE FOR MARCH, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	34.1	58	—4	62	9.8	36	S	0 64	0 30	8
	Portland, Me.	37.4	62	21	41	6.9	28	NW	1.21	0.34	9
	New York City	43.7	69	24	45	11.1	33	N	2.92	0.81	17
	Pittsburg, Pa.	47.8	78	20	58	6.7	32	NW	5.45	2.04	13
	Chicago, Ill.	40.4	68	21	47	17 5	62	W	4.60	1.84	14
	Omaha, Neb.	39.2	68	11	57	9.2	36	SE	1.15	0.57	8
	St. Paul, Minn.	34.5	61	11	50	9.0	32	S	1.96	1 02	10
	Duluth, Minn.	30.6	57	6	51	12.2	46	NE	0.75	0.17	10
	Bismarck, N. Dak.	23.4	66	—11	77	10.7	48	W	1.10	0.56	10
	Average.	36.8	65	11	54	10.4	39		2.19	0.85	11
Southern Cities.	Washington, D. C.	48.8	78	25	53	7.1	25	NW	2.52	0.65	15
	Louisville, Ky.	51.2	75	28	47	9.1	42	W	9.94	1 91	17
	St. Louis, Mo.	47.2	75	27	48	9.9	49	SW	7.73	1.76	14
	Savannah, Ga.	64.0	87	37	50	8.9	51	NE	1.93	1.78	3
	Kansas City, Mo.	45.0	70	18	52	9.0	36	NW	4.50	1.58	12
	Jacksonville, Fla.	66.7	87	42	45	8.2	26	NE	2.04	2.02	3
	Chattanooga, Tenn.	56.6	82	29	53	8.8	28	S	2.68	0.95	13
	New Orleans, La.	65.0	82	39	43	10 8	35	SE	0 80	0.49	6
	Memphis, Tenn.	56.8	83	30	53	12.2	44	W	4.73	1.71	10
	Palestine, Tex.	59.2	86	31	55	9.2	27	SE	2.24	0 91	11
	Average.	56.0	80	31	50	9.3	36		3.91	1.38	10
Western Cities.	Helena, Mont.	23.4	58	—16	74	7 0	40	SW	2.39	0.78	15
	Port Angeles, Wash.	40.5	53	26	27	6.7	30	W	1 38	0.21	13
	San Francisco, Cal.	51.2	74	40	34	10.4	40	W	0.24	0 13	5
	Salt Lake City, Utah.	36.3	63	11	52	6.9	36	SW	1.71	0 45	11
	Santa Fe, N. Mex.	37 6	61	14	47	7.1	36	SW	0.88	0.57	5
	Denver, Colo.	35.7	67	0	67	9.2	53	NW	0 28	0 10	7
	Yuma, Ariz	59 7	86	35	51	—	42	W	0.39	0.39	2
	Average.	40.6	66	16	50	7.9	40		1.04	0.38	8

Manchester, No. 4th, 1794.

Gentlemen,—I shall esteem it a favour to be informed of the expense of a steam engine with a rotative movement of the purchase of 3 or 4 horses, which is designed to be placed in a boat. You will be so good as to mention what sized boat it would occupy, and I wish to have it in as little space as possible; and what you concive will be the expense when finiseed compleat in the boat; whether you have one ready of the dimensions specified, or how soon one might be finished, with the weight of coals which it will consume in 12 hours; and what quantity of purchase you allow to each horse. As I am anxious to apply some engines of the above dimensions as soon as possible, your emediate answer will oblige your

Most obedient and humble servant

Bridgewater Arms, Manchester. Robt. Fulton.

Paris the 6th of August 1803.

Messrs. Boulton & Watt,
Birmingham.

Gentlemen,—If there is not a law which prohibits the exportation of steam engines to the United States of America, or if you can get a permit to export parts of an engine, will you be so good as to make me a cylinder of a 24 horse-power double effect, the piston making a 4-ft. stroke; also the piston and piston-rod.

The valves and movements for opening and shutting them.

The air-pump piston and rod.

The condenser with its communications to the cylinder and air-pump.

The bottom of the cylinder cast in form as in the drawing, and the disposition of the parts as near as possible as they stand in the drawing. The other parts can be made at New York, as it will save the expense of transport, and they require a particular arrangement which must be done while I am present. I prefer having them done there. Therefore if it is permitted to export the above parts, you will confer on me a great obligation by favouring me with them, and placing me the —— on your list —— when finished please to pack them in such a manner as not to receive injury and send them to the nearest port which I suppose is Liverpool to be shipped to New York to the address of Brockhurst Livingston, Esqre., the amount of the expenses will be placed to your order in the hands of Mr. George Wm. Erving, American Consul, Nicholas lane, Lombard street, No. 10, London. The situation for which this engine is designed and the machinery which is to be combined with it, will not admit of placing the condensor under the cylinders as usual, but I hope the communicating tube to the condensor will not render the condensation less perfect or injure the making of the engine.

Should you find a difficulty in getting a permit to export the parts above mentioned, I hope to be able to obtain it through our minister, Mr. Monroe. And as there is some difficulty in passing letters to and from Paris and Birmingham, which may lose much time, you will be so good as to furnish me the above parts as soon as possible without waiting to hear further from me.

Please to write as soon as possible under cover to Mr. Erving, as before mentioned. In which I beg you to answer the following questions:

What might be the size of the boiler for such an engine; how much space for the water and how much for the steam. What is the most improved method of making the boiler and economic mode of setting it? How many pounds of coal will such an engine require per hour, and what is the expense at Birmingham?

Can you inform me what is the difference in heating with coals or wood, as in most cases wood must be used in America; and must not the furnace be made different when wood is to be used?

What will be the consequence of condensing with water salt, as in places where the engine is to work the water is brackish?

What will be the interior and exterior diameter of the cylinder and its length, and what will be the velocity of the piston per second? This information will enable me to combine the other parts of the machinery.

When can the engine be finished, and how much will be the expense? Your favouring me with the execution of this order and answering the above questions will very much oblige your most obedient Robert Fulton.

Rue Vangirard No. 50 a Paris.

Can the position and arrangement of the cylinder condensor and air pump be adhered to as in the drawing without injuring the working of the engine?

The drawing referred to is a colored sketch showing a cylinder, condenser, and air pump.

Messrs. Bolton Watt and Co.

Gentlemen,—I like your mode of placing the air pump in the condensor, but as my movements confine me to 3 ft. in width, the condensing vat ought not to exceed that width, could not the condenser be made like a box, about 4 ft. long, 20 in. wide, and 2 ft. deep, as in this sketch? If so, I shall be completely accommodated; if not, you must use your particular composition of the parts. I must beg of you, however, to fit me in this respect; if possible, perhaps a hole at A may be convenient for a man to pass his arm and draw any chips or dirt which might get into the or rather under the valve of the air pump, the whole to be covered with a plate. In a former letter I mentioned that the air pump will have a stroke of two feet. I see by your drawing you have it 16 inches diametor in the interior. I presume this width is calculated accordingly.

On Tuesday I go out of town for 6 weeks or two months. I shall not trouble you farther about the combinations you will have the goodness to proceed immediately to the construction on the manner you deem best suited to my purpose.

I am with much respect
Yours

London the 28th of July 1804. R. Fulton.

"MAUJAK" IS A MATERIAL found in Barbadoes. It is of a brilliant black color and is deposited in beds, from 10 ins. to 2 ft. thick, immediately below the general surface. It is believed to be solidified petroleum and in composition it is analogous to the Trinity Island tar, and to the Gilsonite of Utah and the Albertite of Canada. But it is distinguished by its good qualities. According to "Wallman's Vers. Zeitung," the best samples contain: Water, 2%; volatile organic substance, 70.85%; solid organic substances, 26.97%, and mineral substances, 0.18%. The Trinity tar contains 21 to 30% of water and 38% of ashes. Maujak is thus rich in bitumen, and it would seem possible to utilize it as a varnish, and as a combustible when mixed with peat. Its insulating properties would also suggest its use as a substitute for gutta-percha in electrical insulation.

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Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 328 means that subscription is paid to the 32d week (that is the issue of Aug. 11) of the year 1898; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The order for 1,000 steel cars recently given by the Pennsylvania Railroad Co. to the Schoen Pressed Steel Co., of Pittsburg, is a good illustration of the fact that the steel car is no longer an experiment; but an accepted type of railway rolling stock. It is a noticeable fact, however, that a large proportion of the steel cars constructed are designed to carry heavier loads than cars of timber construction. The new Pennsylvania cars, for example, are to carry 110,000 lbs. of ore, or 104,000 lbs. of coal. Their dead weight will be 37,000 lbs. and their length will be 33 ft. The competition of the steel car with wooden cars of ordinary capacity will not be apparent probably for some time; but that it will come eventually, the increasing cost of timber and the decreasing cost of steel construction makes very certain.

A little nonsense now and then is relished even by engineers, and it may be found sometimes even in engineering journals, especially in their advertising columns. A recent instance is a full-page advertisement in the April issue of "Power," of a certain "world renowned" injector. It gives the results of tests made by a "chemical and physical laboratory" which are said to be "of vital importance to every engineer and steam user." The report of the tests is headed "Certificate of Physical Demonstration, Whole No. 12,332." This imposing "Whole No." would indicate that the laboratory has done an enormous amount of business, and that it also must be "world renowned," but we regret to say that this is the first report we have ever seen from it. We must have missed a lot of fun in not having seen the other 12,331. The certificate begins as follows:

> The injector was placed in position in ordinary work with such work as happened to be under way at the time, no special preparations, save measuring and weighing appliances used in making the tests.
>
> Data as shown by appliances used:
>
> | | |
> |---|---|
> | Pressure | 85 lbs |
> | Temperature | 316.021° |
> | Heat units | 1178.326 |
> | Latent heat | 891.286 |
> | Weight cubic foot of steam | .2010 |
> | Volume | 5.05 |
> | Temperature of feed water | 160° |

It is not stated whether the pressure is absolute or gage pressure, or whether the temperature of feed was taken before or after the water passed the injector. The other figures, given to the third decimal place, are impressive, but they are certainly not "data as shown by appliances used," but are simply figures taken from a steam table, corresponding to 85 lbs. absolute pressure. The "data" are defective in not showing the number of pounds of water raised per pound of steam used, nor the increase in temperature of the water in passing through the injector. The following paragraph is a gem of "advanced physics" and also of "English as she is wrote:"

> After a temperature of 32° F. has been reached, it is to be understood that it takes double the fuel to raise the temperature of the feed water one degree, than before; and the very best method known to advanced physics to induce a body of water to absorb heat is to thoroughly incorporate it instead of applying to a single surface, on the hypothesis that the more exposed the surface contact the greater the area of absorption; and this is admirably illustrated by the use of this particular injector, as each drop, as shown by my recorder, is made to circulate through the entire mass of water in the boiler, and heats where it is cold, by the more ordinary methods of feeding the boiler with water.

While the imperfect data that are published do not show it, we are informed in the report that the injector gave a "saving in fuel of 6.64%," with the following lucid explanation:

> This means a saving over any appliances used for kindred purposes, and based on the actual heat units absorbed in injecting water into the boiler at above pressure, and I consider this a remarkable showing, especially when it is known that the injector was not made or fitted for a special test, but was, as I have every reason to believe, taken from stock; in fact, I have another one of a smaller size, that has performed remarkable results, and was purchased from an agent.

The concluding paragraph is as follows:

> The actual lift of this injector is 24 ft. 11 ins., according to demonstrations made by others as well as myself. As to the actual efficacy of this injector, many would state it very high, to attain which it would be necessary to sacrifice other characteristics which should not be ignored in tests of this kind. I do not feel that I can report over 99.22%, although a better showing could be made by ignoring some of the little things which go to make up a grand total.

An efficiency of 99.22% not sacrificing "other characteristics" and not "ignoring some of the little things" is quite a modest claim, and it gives us a favorable opinion of this "advanced" physicist. It shows good judgment also on the part of the advertiser to publish the figure, which looks well in print and is calculated to impress the layman, who expects not over 85% efficiency out of any steam appliance. It is also well to suppress, in this kind of an advertisement, the fact, well known to engineers, that all injectors may be made to show an equal thermodynamic efficiency if they are equally protected from loss by radiation. The layman also is not supposed to know that a saving of fuel of 6.64% by any injector is absurd and impossible. The manufacturer himself probably does not know it, nor does the proprietor of the "chemical and physical testing laboratory." The latter made the best kind of report he knew how to make, and put into it more "advanced physics" than anyone else knows. The advertisement is an admirable one, and we hope our contemporary will get many more full-page advertisements that are equally instructive and amusing.

The New York authorities are trying to increase the toll rates paid by the Brooklyn electric railway companies for the privilege of running their cars across the Brooklyn Bridge. These cars have now been running regularly for many weeks, carrying passengers to and from all parts of Brooklyn and for a single fare. They have proved so attractive to the public that they have taken about half the traffic across the bridge and the falling off in the receipts of the bridge cars proper on account of the diversion of traffic is estimated to be at the rate of $700,000 per annum. This loss in the public revenues, however, does not mean a gain to the electric railway companies, but a saving to the public that travels back and forth across the bridge. It is difficult to see, therefore, why the railway companies should be expected to increase their toll payments to make good the bridge revenues, unless they are permitted at the same time to charge an extra fare to passengers for crossing the bridge.

The fact is that the bridge authorities ought to look forward to the offsetting of the loss in the bridge revenues by a corresponding reduction in its expense. The earnings of the bridge in the past have been nearly all absorbed in paying the operating expenses of the bridge, and these operating expenses, with the exception of the cost of policing the structure, have been almost wholly composed of the cost of operating the bridge railway.

The running of through lines of electric cars across the bridge has relieved the bridge railway of half its traffic, although it has reduced its operating expenses only a trifling amount. In the near future the Brooklyn elevated railways will run their cars over the tracks of the bridge railway; and when that is an accomplished fact, the present bridge cable railway service can well be discontinued, except in so far as its maintenance for the safe control of the movements of the cars across the structure may be necessary. Under such conditions the cost of maintenance of the bridge should easily be met by the receipts from rentals and from car tolls no greater than are at present charged. As for the interest on the cost of the structure, the net earnings from the traffic across it have never been sufficient to pay but a small part of this. The city treasury should meet this charge in the future, as it has done in the past. There is really no more reason why extra fare should be charged to passengers crossing the Brooklyn Bridge to pay the interest on the cost of the structure than there is why passengers crossing the city bridges across the Harlem River should be taxed for a similar purpose.

An example of the exceeding unreliability of newspaper reports of technical matters is furnished by the accounts which were published in several papers a short time ago of a 16-story concrete warehouse in Detroit. The "Philadelphia Record" published a view of the building and described it in considerable detail. The New York "Tribune" published a similar account. Yet our inquiries of engineers resident in Detroit and engaged in iron and steel construction have failed to reveal any such structure either under construction or in prospect. It is a good thing in these times not to believe all we read.

A new source of danger from fire has developed in the use of oil under pressure in water-wheel governors. On March 17 the water-power electric lighting station of the Central Massachusetts Electric Lighting Co., at Palmer, Mass., was burned under the following circumstances. The wheel which operates the station is controlled by a Lombard water-wheel governor, an apparatus in which oil is pumped under a pressure of 200 to 250 lbs. into a closed tank, the upper part of which contains air. The oil operates pistons which control the water-wheel gates, and circulates in a closed pipe system. The total amount of oil in the governor is 15 to 20 gallons. The Superintendent of the station with an assistant were adjusting the governor, when some part burst and the escaping oil was ignited, probably by a stove in the room. Both men were badly burned, and the building was destroyed before the fire department reached it.

The accident is instructive, as it calls attention to a danger that has probably occurred to few engineers who use machines in which oil is circulated under pressure. It would seem quite feasible to substitute some other liquid, a mixture of glycerine and water, for example, in place of oil for water-wheel governors of this class.

AMERICAN BRIDGE SHOP PRACTICE.

It is perhaps not as often remembered by engineers at it should be that a goodly part of the pride which we all rightly take in the present high standards of American bridge construction is due to the liberality displayed by bridge manufacturers in improving their equipment and their standards of shop practice to meet every new demand of their expert customers. In few branches of engineering industry has the progress of the professional engineer been more closely in touch with the manufacturer than in bridge building. No one probably will contend that this advance would have been so rapid or so great if the initiative had been left solely to the manufacturer, and no engineer is likely to forget that oftentimes the spirit of opposition has been annoyingly prominent; indeed, it cannot be said that the simple desire for better design and construction has always

been sufficient to cause the manufacturer to make progress. Severe and increasing competition has been the real controlling force in many cases. But when all this is said, no engineer, we think, can justly deny that the bridge manufacturer deserves a large measure of the credit for advanced standards of workmanship and material in American bridge construction.

It is a good practice for engineers to keep in touch with bridge shop methods, not only to set their ideas straight upon the matters just mentioned, but also to refresh their knowledge of prevailing shop methods and to choose judiciously between competing manufacturers in questions of capacity, workmanship, reliability, and a variety of other matters concerning which an accurate knowledge of differing shop practice is of the greatest value in serving their clients. Partly to call attention to the variety of information to be gained by such personal visits, a member of the editorial staff of this journal recently visited a score or more of the more prominent bridge works of the eastern states. Certain special features of the information collected during these visits have been presented to our readers in the series of five articles, entitled "Notes from American Bridge Shops," which is concluded in this issue. The broader questions of prevailing practice and tendencies have not, however, been touched upon in these special articles, and it may afford some hints of value to our readers if they are briefly summarized.

The present tendency of bridge manufacturers is decidedly in the direction of large, well lighted, well heated, roomy shop buildings of iron and steel. In these respects, indeed, some of the newer bridge shop buildings are especially deserving of mention. Others of the older and smaller bridge companies are still housed in the low, gloomy, cramped, wooden shop buildings of 20 or 30 years ago; but these are comparatively few in number and their owners look anxiously forward to the time when conditions will justify the building of modern structures. The bridge shop is necessarily a single-story structure, and on account of the large units to be handled must have large lateral dimensions. Light and ventilation are, therefore, elements reasonably easy to secure. Generally roof skylights or monitors are depended upon mainly for both, although in some of the long narrow buildings these are not used and reliance is placed entirely upon very ample side window area. This statement refers, of course, to rivet and template shops more particularly, as in the forge shop foul gases, smoke, cinders, etc., make skylights and ridge ventilators almost compulsory.

The movement of material inside the shops proper is almost invariably by push cars and overhead trolleys. Generally the longitudinal movement is by the push cars and the transverse movement by the overhead trolleys running on the lower chords of the roof trusses. Occasionally these two devices are supplemented by overhead longitudinal runways, which are, however, usually employed to handle material to and from special gangs or groups of tools rather than for general transportation. Traveling bridge cranes, when used, which is infrequent, generally cover some special part of the shop, such, for example, as the assembling and loading skids, where rapid and more than commonly long individual movements are desired. The push car tracks are narrow gage, seldom over 36 ins., and transferring the cars from one track to another is accomplished either by switches or by turntables, the latter method being perhaps the most common. In some of the newer shops considerable study is given to the construction of the trolleys to avoid friction; they have roller or ball journal bearings, run on half-round rails, and employ unusually careful design and construction in all the parts liable to friction. The hoists employed with these overhead trolleys are usually chain hoists operated by hand. In only a few shops are air hoists used with the trolleys to any extent.

Traveling bridge cranes, although not much used inside the shops proper, seem to have gained considerable favor for yard use, where they are usually built to run at right angles to the railway and push car tracks and serve almost exclusively to transfer loads from one track to another or to and from the storage skids. In some plants where the yard is long and narrow, however, the bridge crane is built to run its whole length and spans practically the entire width. Other methods employed to handle material in the yards are traveling jib cranes and various combinations of fixed derricks and push-car tracks. In the latter arrangement the derricks are, of course, simply used for loading while the actual transportation is done by the push cars.

Taking up the individual classes of tools used in the main or rivet shop those for straightening the material and cutting it to length are first in order of employment. Generally nowadays the material comes from the steel mills fairly straight, but there is always some slight rectification necessary, and for this machinery is used almost exclusively, although occasionally in some of the older shops straightening is still done by hand. For cutting material to length and trimming it, special shears are used for plates and angles, while for I-beams, channels, tees, Z-bars and other irregular shapes cold saws are more economical and are generally used. The salient improvements in this class of work in recent years are the use of special plate edge planes and angle shears adjustable to make either square or bevel cuts without shifting the bar, and generally capable of cutting two angles at the same time. These angle shears are often but not always operated by independent engines. Perhaps taken altogether the advance in efficiency and accuracy has been as great in these tools for the rougher work of shearing and trimming as in any department of bridge shop practice.

Undoubtedly the greatest advance which has taken place in punching bridge material has been the development of the multiple punch, by which webs and angles are punched with a rapidity and accuracy which practically revolutionizes this class of work. Only a few of the larger works, however, as yet employ multiple punches, which is somewhat surprising considering the obvious advantages of such tools. Not only is punched work turned out more rapidly and cheaply by them, but they economize materially in template work and handling. With their elaborate spacing table for longitudinal spacing, and the great variety of transverse adjustments of which the punches are capable, the problem of "laying out" ordinary floor beam stringer and chord work and especially plate girder work is practically eliminated. Moreover, the work done by these punches is extremely good, mainly, of course, because they are more or less automatic. For drilling, single drills are used almost exclusively, it being most unusual to see a multiple drilling machine in bridge shops.

Where punched work is adopted it is often specified that the punched holes should be reamed after the members are assembled, and this means a heavy expense in handling if the assembled members have to be moved often. The usual practice, therefore, is to move the comparatively light tool to the work rather than to shift the work itself. Various methods have been devised to accomplish this, among which radial reamers arranged in gangs so that their individual fields of action overlap each other slightly and in the aggregate cover a considerable horizontal area, and portable hand reamers operated by flexible shafting or compressed air, are most common. The chief end to be attained in any arrangement is, of course, quickness of action while reaming, and ease in reaching all parts of the work. In other words, here as in riveting, the capacity of the tool is generally limited by the ability to supply its work to it and anything which facilitates the quick shifting of the tool from one hole to the next is a valuable acquisition.

The pneumatic reamer seems to be especially flexible in this respect, and a visitor to any modern bridge plant will be struck by the extensive adoption of this comparatively new tool, as well as with the growing use of chippers operated by compressed air. The advantage, both in workmanship and speed, which this latter tool offers for chipping and trimming over the old cold chisel and hammer method, is decidedly apparent upon even the most cursory inspection of the two operations. In fact we are inclined to believe that in these two tools and in supplying power to riveting machines compressed air has reached its highest usefulness in bridge work up to the present time.

In riveting fully as much as in reaming it is found neither profitable nor convenient to move the work to the machines, but is far better to bring the machines to the work. For these portable machines no power seems better adapted than compressed air, as it can be readily transmitted through flexible hose which is very light and easily handled. Stationary riveters, however, are fully as well adapted to hydraulic or steam power, and these agents are in fact generally used. For very powerful riveters no power probably is so good as hydraulic, as with pressures of 900 lbs to 3,000 lbs. per square inch comparatively small cylinders can be used, which makes a correspondingly lighter tool to handle. At the best a riveter is a pretty heavy tool, however, and it requires a far more elaborate arrangement for its handling than do reamers, which are often carried about by one or two men. The point, therefore, at which it is preferable to shift the tool instead of the work is not so soon reached as in the case of reamers. Generally, when work exceeds two tons in weight, however, it is found better to bring the riveters to it. This is done in a variety of ways, the most common of which is perhaps an overhead runway on which travel several carriages, each of which carries a riveter. The transverse trolleys and individual cranes are sometimes used for this purpose also, and for hydraulic riveters special T-cranes having trolley tracks upon their booms are frequently employed. Except occasionally for cold riveting on light work, percussion riveters are not used in shop riveting, as far as our observation extended.

The two main items in finishing riveted members are boring the pin holes and machining the bearing ends. For the first of these processes the tendency at the present time is toward double instead of single spindle boring machines. These double tools bore the holes in the opposite ends of the member at one time, doing away with all reversing of the work necessary with a single spindle tool, and also avoiding the chances of faulty alinement and spacing due to two or more adjustments. Practically the same tool is now generally used for boring the pin holes in forged eye-bars. For machining the ends of compression members, floor beams, etc., the tool most commonly used is the rotary planer, and the latest improved types of these tools have swinging heads by which bevel or square cuts can be made with the work always occupying the same position on the table. Double headed planers are not used, but the reversing of the work is avoided in some shops by having two planers placed facing each other a sufficient distance apart to give room between them for the longest member likely to be built. The bulk of the remaining machine work in bridge shops outside of repairs is the finishing of pins and segmental rollers, which is comparatively simple, lathe work and the ordinary planer work of machining bearing shoes, roller beds, and other cast metal work.

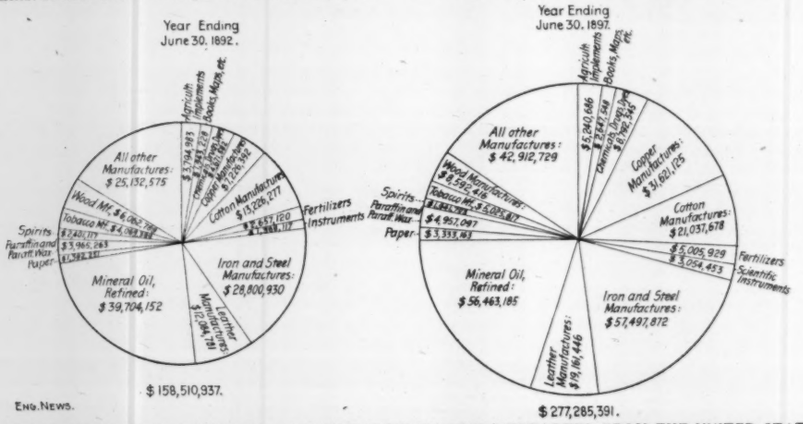
The equipment of a bridge forge shop depends upon whether it manufactures steel eye-bars or not. If it does not the work is little more than heavy smith work and the equipment is confined mostly to small tools and comparatively light power hammers. Where steel eye-bars are forged, however, the plant is much more elaborate, comprising, as it must, upsetting machines, powerful steam hammers, presses and rolls and an annealing furnace of greater or less capacity. Of course, only a few shops are equipped to do the heaviest class of steel eye-bar work. Wherever natural gas is available it is usually preferred for heating furnaces for eye-bar and all heavy forge work on account of the rapid and uniform heat which it gives to large pieces. The same fuel is also often used in the rivet heating furnaces and smaller forges, but not so commonly as in eye-bar work. On the whole the general tendency in the forge shop as in the other shops of a bridge works is to employ special machines more and more, particularly power presses which forge to special dies, and heavy steam hammers.

The template and pattern shop practice for bridge work is nearly the same everywhere, about the only difference being that in some establishments more of the detailing is left to the template shop than in others. In some works, for instance, it is customary to locate on the working drawings all rivet spacing, all holes, and all bevels and angles, while in others these details are shown on the drawings only in a general way and the work is laid out fully in the template making. The advantage claimed by those who use the last method is that if the work is laid out to full size and all connections are assembled in the template shop, errors in detailing which might escape the drafting room are discovered and corrected before the work reaches the shops. The objections made by others to this method are that it requires a very large template shop and extensive floor area to lay out the material so fully, and, finally, that if duplicates have to be made after the template is destroyed the original drawings do not show what the actual details were and a great deal of trouble is entailed. On the whole the weight of opinion is probably in favor of making the shop drawings complete in all details.

In the minor details of drawing room practice each shop has its special "wrinkles" and pet methods which differ from all others, and it would be a task altogether disproportionate to the general value of the result to try and sift out their respective merits. Wherever it seemed particularly valuable to do so, moreover, these various drafting room methods have been briefly described in the special articles to which we referred above.

FIVE YEARS' GROWTH OF THE UNITED STATES EXPORTS OF MANUFACTURES.

The Bureau of Statistics of the Treasury Department, under the able direction of Mr. Worthington C. Ford, is making extended use of diagrams for the purpose of more clearly presenting the important facts which are obtained in the course of its work. One of the most interesting of these diagrams forms the frontispiece of the bulky report on "The Foreign Commerce and Navigation of the United States for the Year Ending June 30, 1897," and is reproduced herewith.


Year Ending June 30, 1892.
All other Manufactures: $ 25,132,575
Wood Mf. $ 6,062,788
Tobacco Mf. $ 6,083,338
Spirits $ 7,480,179
Paraffin and Paraff. Wax $ 3,966,263
Paper $ 1,382,330
Mineral Oil, Refined: $ 39,704,152
Iron and Steel Manufactures: $ 28,800,930
Leather Manufactures: $ 12,084,791
Cotton Manufactures $ 13,228,277
Fertilizers $ 2,657,120
Instruments $ 4,349,119
$ 158,510,937.
Eng. News.
Year Ending June 30, 1897.
All other Manufactures: $ 42,912,729
Wood Manufactures: $ 8,512,416
Tobacco Mf. $ 5,075,817
Spirits $ 1,843,704
Paraffin and Paraff. Wax $ 4,957,097
Paper $ 3,333,163
Mineral Oil, Refined: $ 56,463,185
Iron and Steel Manufactures: $ 57,497,872
Leather Manufactures: $ 19,161,446
Cotton Manufactures: $ 21,037,678
Copper Manufactures: $ 9,162,125
Fertilizers $ 5,005,929
Scientific Instruments $ 3,054,453
$ 277,285,391.

FIVE YEARS' GROWTH IN THE VALUE OF MANUFACTURED GOODS EXPORTED FROM THE UNITED STATES.

As our readers will remember, 1892 was the last of the five "fat" years which began with 1888; while 1897 was the last of the five "lean" years which began with the year of the Columbian Exposition. That during these years of hard times and industrial depression we should increase our exports of manufactured goods from 158 millions to 277 millions of dollars in value is indeed a remarkable showing. The most striking increase is the growth in iron and steel exports from 29 millions to 57½ million dollars, or nearly double; but the growth in exports of copper and its manufactures, which we presume includes electrical machinery, is hardly less significant.

One point which should be borne in mind in examining these diagrams is that they considerably understate the actual increase in the volume of our exports of manufactured goods. The comparison is not between amounts of goods, but values, and these values are made up, if we are correctly informed, on the invoice value of the goods. But these values are dependent on the market prices, and there is hardly a line of manufactures in which prices were not materially lower in 1897 than in 1892. Taking this fact into consideration, we presume that the volume of our exports of manufactured goods was more than doubled in the five years under consideration.

LETTERS TO THE EDITOR.

Recollections of a Civil Engineer.

Sir: I was born and bred in a quiet village of Buck's county, Pa. My father worked a small farm which furnished the main sustenance for his family, but, being of Connecticut descent, he could turn his hand to almost any trade and was his own blacksmith, mason, carpenter and cooper. In the fall of the year it was his custom to make a two-months' trip across the state with his team of black horses for the purpose of selling clocks and tinware; the profit of this enterprise was sometimes very considerable and enabled us to indulge in a few small luxuries as well as constantly to improve the farm. The return of my father from one of these trips was eagerly awaited by his family and neighbors, for he had always interesting adventures to relate and valuable information to give regarding manufacture and public improvements.

Early in December, 1828, when I was about eight and one-half years old, my father returned from his annual expedition with the usual stock of stories, and one of these made a deep impression on my mind. Indeed, I have often thought that this story was the beginning of my career as a civil engineer. Why is it that the mind of a boy is sometimes powerfully influenced by the simple narration of a trivial incident, while speeches, sermons and statements of important facts produce little effect? Certain it is that there are times when the youthful mind is particularly impressionable, when a chance remark may inspire latent energy and evolve aspirations that control conduct and purpose through all the years of life.

The incident that my father related was connected with the construction of the canal from the coal regions of Pennsylvania to the Delaware River, then and now called the Lehigh canal, and with the chain bridge that spanned the Lehigh River at Northampton, now known as Allentown. He was on the road from Easton to Pottsville, and in passing through Bethlehem had been told to be careful in approaching the chain bridge on account of the blasting operations that the canal people were carrying on near it. Exercising due caution he safely reached the toll house and stopped to witness the excavation work, when he was informed that it would be best to cross the bridge as a blast was soon to be let off. Accordingly, he put his horses into as rapid step as the law allowed, and had reached the middle of the second span when the explosion occurred. A glance backward showed that the air was filled with flying rocks, and instinctively my father gave rein and whip to his team. It was well that he did so, for a huge rock descended upon one of the bridge chains which instantly snapped asunder by the shock, and just as the wagon reached a place of safety on the abutment, the whole bridge swayed and creaked, while the floor of one of the spans, no longer supported by the chain on one side, fell into a tangled mass that threatened every moment to drag down the other chain with it into the stream beneath.

Seventy years ago this accident happened, and looking back over the events of a long and busy life I can recall no incident which has more vividly impressed my imagination that that of the flying rock impinging upon the bridge chain. The bridge has long since gone, and the Lehigh canal, although still in operation, is relatively unimportant; yet in the days when civil engineering was young they were constructions that claimed admiration, and the lessons taught by their builders have exerted a wide influence. To the present generation, even the names of these men are quite unknown; therefore, let me say a few words that may tend to preserve their memories.

I never knew James Finley, the inventor of the modern suspension bridge, but I can say from an examination of several of his structures that he was a born engineer. His first bridge, which was erected over Jacob's creek in 1801, contained the two distinctive elements of the suspension system, the chains passing over towers and anchored to rock abutments, and the horizontal floor hung by vertical rods from the graceful chains. In 1808 Finley took out a patent for this system and in the ten years following more than a dozen bridges were built by him in Pennsylvania. Most of these had a span of about 125 ft. between the towers, but one at the Falls of the Schuylkill had two spans of a total length of 306 ft. The one over the Lehigh at Allentown was generally spoken of as having "two loops and two half-loops;" that is, there were two main spans and two approach spans, the total length being 520 ft. When a young man I saw this bridge twice, and the beauty of its form aroused my admiration, while the details of its construction gave me ideas which were of much value in subsequent practice. In 1811, when it was carried away by the great flood, I experienced a feeling of real personal loss.

The moving spirit in the construction of the Lehigh canal was Josiah White, a man of most remarkable energy. It was begun in midsummer, 1827, and on June 16, 1829, the first boat load of coal started from Mauch Chunk for Philadelphia. Two years for the construction of a canal 47 miles long with 49 locks would be quick time even in these days, but Josiah White laid his plans with shrewd foresight and his indomitable perseverance conquered all obstacles. One of the elements of his success was his knowledge of men; he seemed to know instinctively just the place a man could fill, and his choice of engineers, superintendents and foremen on the canal was such that all worked in harmony to execute his comprehensive plans.

The chief engineer of this canal was Canvass White. He was not a relative of Josiah White, the latter being of a Pennsylvania family, and a Friend, while the former came of Puritan stock. When I was 13 years old my father took me with him on a journey to Trenton, and there I saw Canvass White, who was then 43 years old. I remember him as a lightly built man with brown hair and wonderfully clear blue eyes. His expression was grave and thoughtful, yet full of kindness, while his voice and manner gave an unmistakable impress of genius. The interview which my father held with him was very brief, but his words produced a lasting impression upon me, and when we came away my resolution to become a civil engineer was firmly fixed.

Canvass White easily stood at the head of American canal engineers in the year 1830. He began work in 1816 on the Erie canal, and soon exhibited such careful judgment that he was sent to England to gather information regarding methods of canal construction and operation. For ten years he devoted his energies to the Erie work and after that was completed he was chief engineer of the Union canal along the Schuylkill, of the Lehigh canal, and of the Delaware & Raritan conal, as well as consulting engineer on several others. Perhaps his greatest service to the profession was the discovery of American hydraulic cement, which was made about the year 1818. After repeated experiments on a limestone rock which he found near the line of the Erie canal, he succeeded in producing from it a hydraulic cement equal in quality to the best imported and at a much less cost. For this important discovery he received no compensation whatever, notwithstanding the promises that had been held out to him by the canal commissioners. He died at the early age of 44, one year after I saw him, and the engineering profession bore unanimous witness to his high genius, his cool judgment, his sterling character, and his successful work.

In the year 1829 an important event occurred that was duly reported by my father on returning from his annual trip. At the time it made little impression on my mind, but looking back as I now do over the history of civil engineering in this country, it stands forth as an epoch-making event. On August 9, 1829, the first locomotive was run on an American railroad track. This occurred at Honesdale, in Wayne county, Pa.; from this place a railroad 16 miles long had been built to connect the mines with the Delaware and Hudson canal, and coal cars were hauled over it by horses. In 1828 Horatio Allen had been sent to England to buy locomotives, and in the summer of 1829 one arrived at Honesdale, was put together, and on August 9 was fired up for trial. A short distance from the station the track ran over a trestle and doubts were expressed as to its safety. Horatio Allen, remarking that if there was any danger only one life ought to be exposed, mounted the engine alone and ran it quickly over the trestle amid the cheers of the assembled crowd. He continued the trip for three miles and then returned safely to the station; the performance of the locomotive was, however, not satisfactory and it was used no more in 1829. In 1830 the second run of a locomotive was made on the Baltimore & Ohio railroad by Peter Cooper, and in 1831 an eight-wheeled engine, designed by Horatio Allen, was

in regular operation in South Carolina. Then, with marvellous rapidity, railroads multiplied in every direction.

After reaching manhood I saw Horatio Allen several times. He was somewhat portly, of quiet manner, simple tastes, and a most kindly disposition. Earnest words of encouragement from him gave inspiration to many young men starting in the race for life. I remember hearing of the great interest he had in astronomy, of the orrery that he constructed, and of the simple scientific books that he wrote for children. He died on the last day of the year 1889, aged nearly 90 years, having witnessed a development of engineering and contributed to its progress to a degree such as has fallen to the lot of few other men. In 1829 there were exactly 40 miles of railroad in the United States and but a single trip was made by the only locomotives then on the rails. Now we have 245,000 miles of track and about 40,000 locomotives, while over (90) millions of miles are annually run by our railway trains. Surely the material progress of 70 years has been most marvellous, but I sometimes wonder if men are today really happier, healthier, better in morals, or keener in intellect, than in the quiet days of my boyhood. Most sincerely do I hope that the industrial development of the age leads to these results. H. E. Licks.

South Bethlehem, Pa., April 14, 1898.

Notes and Queries.

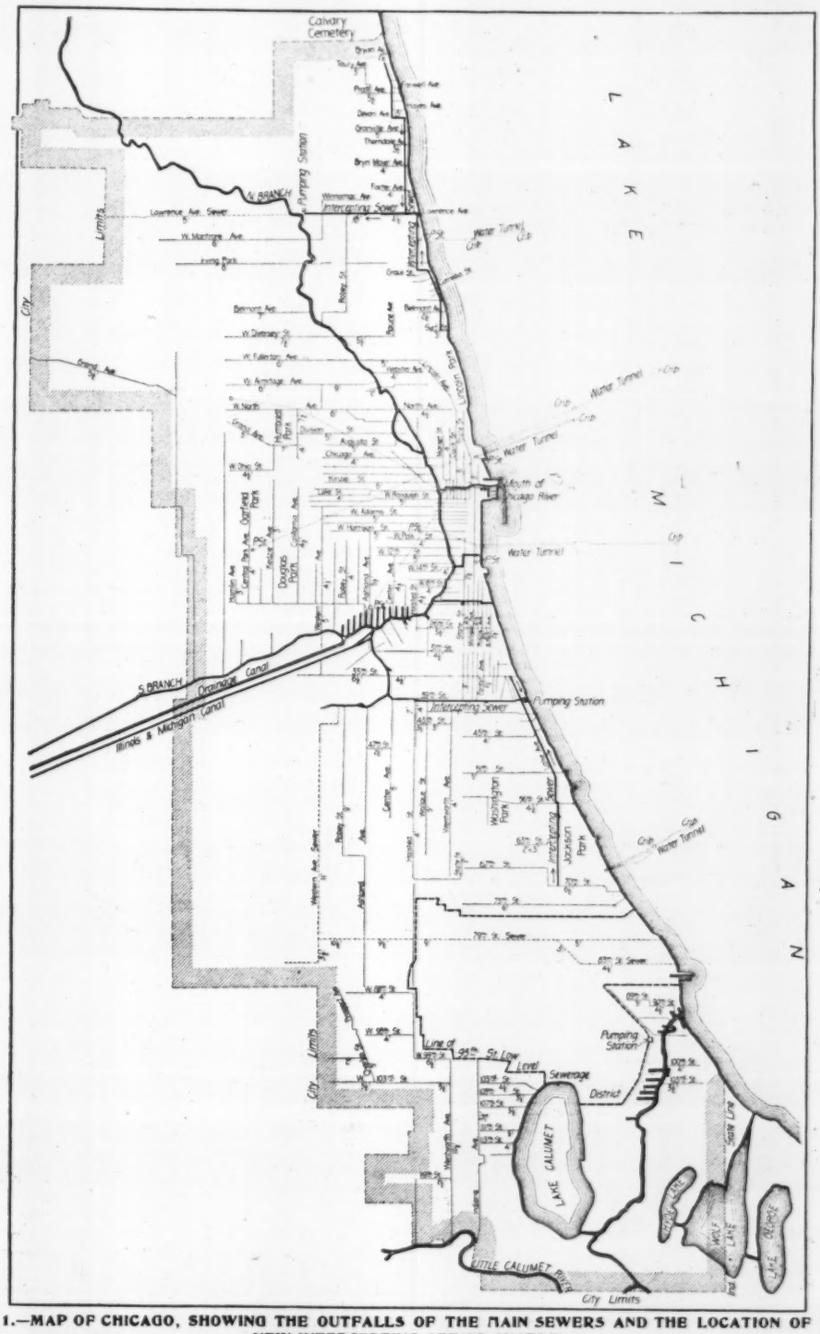
Concerning the rack-rail locomotives of the Beirut & Damascus Ry., described and illustrated in our issue of April 7, a correspondent reminds us that the special inlet through which the cylinders take air when working as air compressors on a down grade is found in some form on nearly every locomotive (rack or adhesion) in which the cylinders are used for braking purposes in descending long and heavy grades. The Adams truck, employed on the engines of the Damascus railway, was invented several years ago by the Locomotive Superintendent of the London & Southwestern Ry., and has been extensively employed on various European railways. Strictly speaking it is not a truck at all, but a radial axle, an arrangement which is favored on English railways in preference to a pony truck, or Bissel truck, as the two-wheel truck is usually termed in England.

The Hercules valves, illustrated in our issue of March 31, we are informed, are not used on the U. S. battleships "Brooklyn" and "Iowa," as we stated, but the valves on these vessels are special all-brass valves, of "government metal" made to order by the makers of the Hercules valves. Our error was due to misunderstanding of the information furnished us by the Michigan Brass & Iron Works, the makers of these valves.

THE NEW INTERCEPTING SEWER SYSTEM FOR CHICAGO.

In accordance with time-honored custom dating from the early days of sewerage systems, the sewers of the city of Chicago have been laid in such a way as to discharge their contents into the nearest body of water, some discharging into the Chicago River and its branches, and others discharging directly into Lake Michigan. With the rapid growth of population the amount of sewage to be disposed of has reached vast proportions, and as the system of disposal has been simply to deposit the sewage in a body of still water or the practically stagnant water of the river, the result has been a state of affairs which is a disgrace to the city and a constant menace to public health. To add to the danger, the city's water supply is drawn directly from the lake, and though the intakes of the water tunnels have been extended farther and farther from the shore, yet even the most distant intake crib is at times reached by the volume of sewage-polluted water from the shore outfalls and the river under certain conditions of wind and weather.

A history of the sewerage system of Chicago was given in the earlier numbers of a series of articles on the Chicago Drainage Channel, which appeared in our columns during 1895, and which have since been republished in book form by the Engineering News Publishing Co. As there stated, the first general plans for a sewerage system were prepared in 1855 by the late Mr. E. S. Chesbrough, M. Am. Soc. C. E., who proposed to discharge the main sewers into the river. Realizing that this would soon produce dangerous pollution if no further steps were taken, he provided for a system of water pipes for flushing the sewers and an open channel on 16th St., from the lake to the South Branch of the river through which water could be forced for flushing the river. The North Branch was to be treated in a similar way when the growth of population should demand it. Mr. Chesbrough recognized, also, that eventually some outlet to the southwest would have to be provided, and, therefore, none of his sewers were laid out to discharge into the lake. As is too often the case, however, the city authorities did not appreciate the foresight and broad views of the engineer, and, against his advice, they rejected the flushing pipe system and the flushing channel, and had some of the sewers built to discharge directly into the lake. The natural result of discharging sewage into the South Branch, and leaving it there to accumulate, was that the condition of the river became so offensive that as long ago as 1860, suggestions were made for a connection with the Illinois & Michigan canal, and through that with the Illinois River, so as to create a current through the Chicago River westward. Plans were adopted in 1865, and work completed in 1871. By this time, however, the North Branch of the river was also becoming offensive from deposits of sewage and factory wastes, and it was, therefore, decided to build a flushing conduit from the lake to the river along the line of Fullerton Ave. This was finished in 1880, but did not answer its purpose, and as the construction of the Ogden Canal, with an eastward flow, practically nullified the effect of the connection with the Illinois & Michigan canal, the condition of sewerage and water supply affairs in 1880 was almost as bad as it had been in 1855.


Calvary Cemetery
N. BRANCH
Pumping Station
Intercepting Sewer
Lawrence Ave. Sewer
W. Madison Ave.
Limits
City
Water Tunnel Crib
Grace St.
Belmont Ave.
W. Diversey
W. Fullerton Ave.
½ Armitage Ave.
W. North Ave.
Humboldt Park
Augusta St.
Chicago Ave.
W. Division St.
W. Chicago Ave.
Garfield Park
W. Madison St.
W. Harrison St.
Douglas Park
Lake St.
Ashland Ave.
Carroll Ave.
Camp Ground
Western Ave.
Robey St.
Lumber Ave.
Halsted St.
Normal Ave.
Union Park
Ogden Ave.
Aberdeen St.
Racine Ave.
Laflin St.
Wood St.
Paulina St.
Lincoln Park
North Ave. Tunnel
Water Tunnel
South of Chicago River
Water Tunnel
Crib
Water Tunnel
S. BRANCH
Drainage Canal
Illinois & Michigan Canal
Pumping Station
Intercepting Sewer
Michigan Park
Jackson Park
Crib
Water Tunnel
Western Ave. Sewer
Lumber St.
Ashland Ave.
Halsted St.
Normal Ave.
Racine Ave.
Wood St.
Paulina St.
Lincoln Park
Ogden Ave.
Aberdeen St.
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W. Madison St.
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Humboldt Park
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W. Diversey
Belmont Ave.
Grace St.
Water Tunnel Crib
Lawrence Ave.
Lawrence Ave. Sewer
W. Madison Ave.
Limits
City
Intercepting Sewer
Winnemac Ave.
Bryn Mawr Ave.
Thorndale Ave.
Granville Ave.
Devon Ave.
Pratt Ave.
Touhy Ave.
Howard Ave.
Rogers Ave.
Calvary Cemetery
Grace St.
Addison St.
Irving Park
Belmont Ave.
Bruce Ave.
Diversey
Fullerton Ave.
Armitage Ave.
North Ave.
Augusta St.
Chicago Ave.
Division St.
Humboldt Park
Garfield Park
Douglas Park
Madison St.
Harrison St.
Polk St.
Taylor St.
Roosevelt St.
Lake St.
Ashland Ave.
Carroll Ave.
Camp Ground
Western Ave.
Robey St.
Lumber St.
Halsted St.
Normal Ave.
Racine Ave.
Wood St.
Paulina St.
Lincoln Park
Ogden Ave.
Aberdeen St.
Laflin St.
Union Park
Jackson Park
Michigan Park
Intercepting Sewer
Pumping Station
Crib
Water Tunnel
Crib
Water Tunnel
Crib
Water Tunnel

problem of diverting the flow of this sewage westward into the river instead of eastward into the lake.

In the present year plans have been adopted by the city of Chicago for a system of intercepting sewers for this purpose, and work has already been commenced. The length of this system will be about 18 miles, and its total cost will be about $3,300,000. At the outset there was some friction between the city authorities and the canal trustees as to the funds for the work, but a compromise was soon arrived at, by which the sewers and the necessary pumping stations and pumping plants will be built and installed by the city, and then

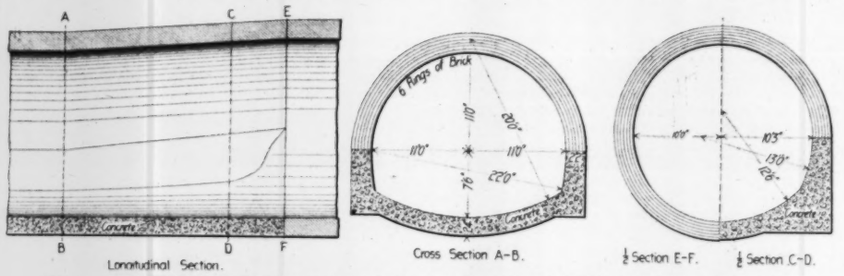


FIG. 3.—CONNECTION BETWEEN HORSESHOE AND CIRCULAR SECTIONS OF 39TH ST. CONDUIT.

turned over to the Drainage Board, which will operate and maintain them. To provide means for immediate construction, the city decided to appropriate a portion of the water fund, the main object of the work being the purification of the water supply. This was opposed by certain parties who favored a plan for abandoning the Chicago River as a navigable stream, covering it over and utilizing it as a drainage conduit. This opposition, however, did not amount to much, and, as already noted, work is now in progress on the intercepting system.

The prompt commencement of work on this much-needed intercepting sewer system is due largely to the energy of Mr. L. E. McGann, Commissioner of Public Works, who has pushed the preliminaries forward vigorously. The plans and specifications have been prepared under the direct supervision of Mr. F. E. Davidson, Superintendent of Sewers, to whom we are indebted for blue prints and general information respecting the work. Mr. Wm. Lowe is Engineer in Charge, and Mr. W. G. MacHarg is Consulting Engineer for this work.

Fig. 1 is a map of the city showing the outfalls of the present main sewers, and the location of the new intercepting sewers, the direction of flow in the latter being indicated by arrows. It will be seen that on the North Side and the South Side of the city there will be a sewer practically parallel with the shore and connecting with a conduit running west to the river. On the North Side, the sewer will extend from Surf St. to Tuohy Ave., following along the line of Lake View Ave., Sheridan Road, Clarendon Ave., and again along Sheridan Road. The flow is northward from Surf St. to Lawrence Ave., and south from Tuohy Ave. to Lawrence Ave. Along Lawrence Ave. will be a 16-ft. conduit, extending to the North Branch of the river, where a pumping station will be erected. These sewers will intercept all the flow north of Lincoln Park, and carry it to the river.

On the South Side there will be a main conduit, 20 ft. diameter, extending along 39th St., from Lake Michigan (where a pumping station will be erected) to the South Branch of the Chicago River at Halsted St. Intercepting sewers connecting with this will run north in Lake Ave. to 35th St. and south in Lake Ave. and Stony Island Ave. to 73d St. The sizes of these sewers will be as follows: From 35th St. to 39th St., in Lake Ave., 6½ ft. diameter; 39th St. to 73d St., in Lake Ave. and Stony Island Ave., 12 ft. diameter; 39th St., to 44th Place, 11¼ ft. diameter; 44th Place to 51st St. and 51st St. to 56th St., 10½ ft. diameter.

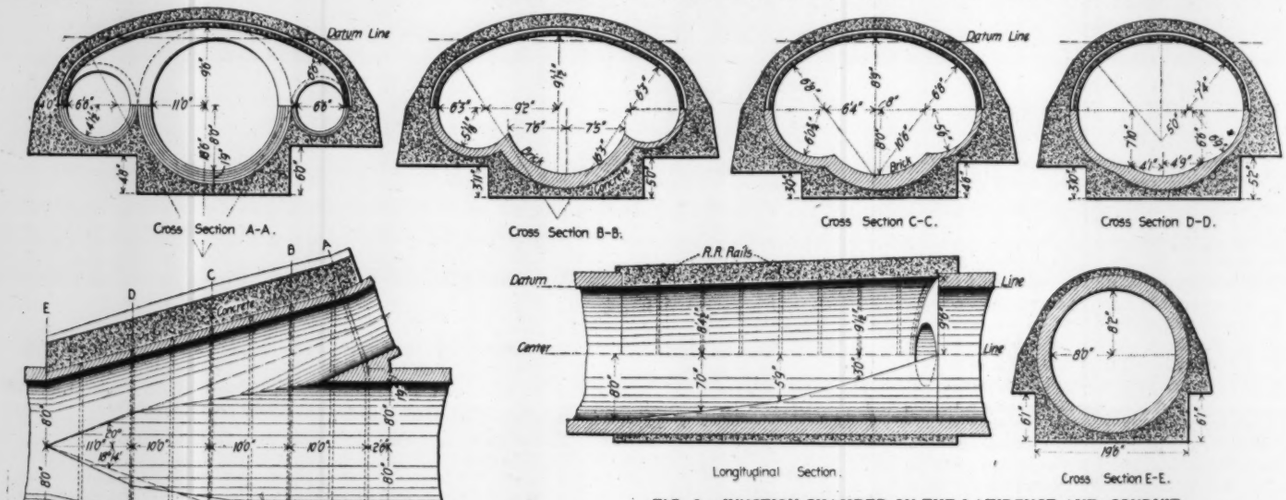


FIG. 2.—JUNCTION CHAMBER ON THE LAWRENCE AVE. CONDUIT.

Besides these, there will be two intercepting sewers on 12th and 22d Sts., extending from the lake to the river. While these latter will not be so large or so long as the others, they will form a very important part of the system, since they will intercept about 40% of the sewage now discharged into the lake. These two sewers were described and illustrated in our issue of Feb. 24, 1898. The following table shows the size and length of the intercepting sewers of the main system:

System.	Diameter, ft.	Length, miles.	Estimated cost.
North Side interceptor....	3½ to 8	6¼	$225,000
Lawrence Ave. conduit...	16	2¼	450,000
South Side interceptor....	6 to 12	4½	850,000
39th St. conduit	20	2¼	950,000
12th St. sewer	4 to 5½	1¼	60,000
22d St. sewer	5 to 8	1¼	80,000
Pumping stations, land, intakes, machinery, etc.. ..		...	685,000
Total		17¾	$3,300,000

Work has been commenced on the two smaller intercepting sewers, on 12th St. and 22d St. noted above, and is to be completed by June 1, 1898. The contracts were let March 7, that for the former being let to James H. Roche at $28,041, and that for the latter to Byrne & Shortall at $65,950 (Eng. News, supplement, March 17). The bids for the Lawrence Ave. and 39th St. conduits were opened April 13, and the lowest bids were as follows: Lawrence Ave., Farley & Green, $479,666; 39th St., the Chicago Star Construction & Dredging Co., $786,591. Work will be commenced as soon as possible after the award of the contracts, and must be completed by April 1, 1899. The intakes and intake foundations for these two conduits will be let as a separate contract, and plans and specifications for this work are now being prepared, and will probably be completed by the end of May. The pumping stations and pumping plants will also be let as separate contracts at a later date. At present the Department of Public Works is completing plans and specifications for the intercepting sewers which will form the north and south arms of both the North Side and South Side conduits, and expects to advertise this work very shortly.

For the district between 79th St., 106th St. and Halsted St., which is a low-lying district of about 10,800 acres, there will be an independent low-level sewerage system, leading to a pumping station and outfall at 95th St. and the Calumet River. This independent system will comprise about 122,187 ft. of brick sewer, from 2½ to 13½ ft. 6 ins. diameter.

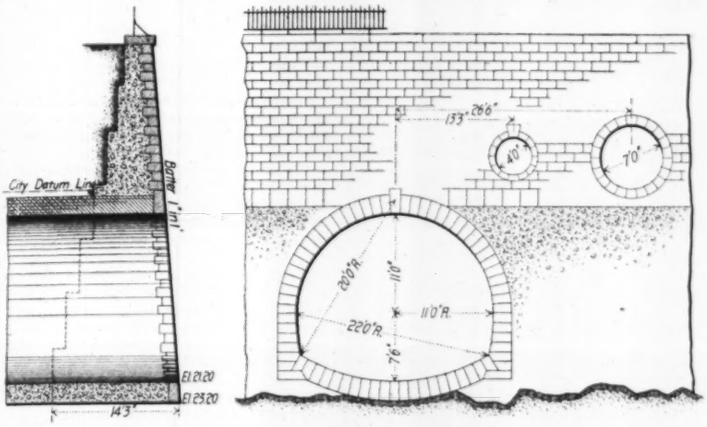
Lawrence Ave. Conduit.

This will extend in a straight line east and west from Lake Michigan to the North Branch of the Chicago River, where a pumping station will be established. This forms Section D of the intercepting system, and will be in two parts: (1) a 16-ft. conduit built in open cut for 3,880 ft. at the east end (from Clarendon Ave. to Beacon St.), with three manholes and a junction chamber, the average depth of cut being 29 ft.; (2), a 16-ft. tunnel for 9,105 ft., with three working shafts. There will also be a considerable amount of additional work, including connections with existing sewers, which work will aggregate 76 ft. of 24-in. brick sewer, 4,566 ft. of 15-in. vitrified pipe sewer, 2,445 ft. of 12-in. vitrified pipe sewer, 57 manholes, 21 catchbasins and numerous siants, house connections, etc. The greater part of this sewer will be in soft blue clay, overlaid by stiff blue clay, and then by sand. The depth of cover over the roof of the sewer built in open cut will be about 7 ft. at the east end and 16 ft. at Beacon St. The depth of cover over the tunnel work will be about 16 ft. for the greater part, with a maximum of about 20 ft. The sewer will be of circular section throughout, with five rings of brick.

Thence there will be a tunnel to 70th St., with a diameter of 9 ft., from 56th to 63d Sts., and 8 ft. from 63d to 70th Sts. From 70th to 72d Sts. the sewer will be 6 ft. diameter, built in open cut.

One of the most interesting pieces of work on this sewer will be the junction chamber at Sheridan Ave., where a 6-ft. sewer from the south and an 8¼-ft. sewer from the north connect with the

16-ft. conduit. Each juction has a curve of 23 ft. radius on the center line, for an arc of about 70°, continued by tangent lines about 42 ft. long, meeting the center line of the conduit at angles of 20° on the north and 18° on the south. This chamber will be of concrete, with a brick lining for the invert, and T-rails, weighing 60 lbs. per yd., will be imbedded in the concrete roof at intervals of 5 ft. Fig. 2 shows the plan and sections of this chamber, from which it will be seen how the bellmouth roof narrows from a radius of 23 ft. to 12 ft. 4 ins. and the three inverts gradually run into the bottom of the standard 16-ft. circular tunnel section.



Longitudinal Section. Front Elevation.

FIG. 4.—MASONRY RETAINING WALL AT OUTFALL OF 39TH ST. CONDUIT.

39th St. Conduit.

This will extend in a straight line east and west from Lake Ave. to the South Branch of the Chicago River at Halsted St., except that it is diverted slightly at the east end, as shown in Fig. 1. It forms Section C of the intercepting system, and like the Lawrence Ave. sewer it will be in two parts: (1) a 20-ft. tunnel from Lake Ave. to Butler St., 9,555 ft.; this will have three working shafts and also a 20-ft. permanent shaft at Lake Ave., the latter having a 6½-ft. opening on the north side and a 4-ft. manhole in the roof; (2) a conduit 22 × 18½ ft., in open cut, from Butler St. to the river, 2,070 ft.; this will have a concrete invert and brick arch, and the average depth of cut will be 38 ft.; it will have six manholes. At Halsted St. there will be a concrete retaining wall, with Bedford stone facing and coping, which will form the outfall for the 20-ft. conduit and two sewers of 7 ft. and 4 ft. diameter, respectively. This will comprise about 1,750 cu. yds. of masonry. There will also be a considerable amount of work in making connections with the existing sewers whose flow is to be intercepted, this work including 1,972 ft. of 12-in. and 625 ft. of 15-in. vitrified pipe sewer, 23 manholes and numerous sewer, house drain and catchbasin connections. From Stewart Ave. to Halsted St. a 12-in. to 15-in. pipe sewer will be laid in a bed of concrete on top of the 20-ft. conduit, connecting with the manholes of the latter at street intersections. The material met with below the level of the roof line will be mainly soft blue clay, with some quicksand, overlaid by yellow sand and wet blue sand. The depth of cover over the tunnel section will be about 12 to 20 ft., and over the section built in open cut, it will be from 12 to 14 ft.

The tunnel portion will be of circular section, 20 ft. inside diameter, with six rings of brick. The part built in open cut will have a six-ring brick arch roof of 11 ft. radius, and concrete side walls and invert, the invert having an inside radius of 20 ft. The clear width inside is 22 ft. with a clear height of 18 ft. 6 ins. The plans for this conical connection between the two types of construction are shown in Fig. 3.

As already noted there will be a permanent shaft 20 ft. in diameter at the intersection of Lake Ave. and 39th St. This will have a sewer opening, or "eye," 6 ft. 6 ins. diameter, in the north side, the bottom of the opening being level with the top of the inside of the conduit. The brick sides of the shaft will be 26 ins. thick, and the roof will be formed by 15-in. I-beams, 6 ins. wide, spaced 30 to 42 ins. apart, and filled in with concrete. Another bed of concrete, 12 ins. thick, will be laid on top of the beams. In this roof will be a manhole extending up to the street surface.

It will be readily understood that the most complicated part of the work lies in effecting the connections with the sewers whose flow is to be intercepted, and the renewal or reconstruction of sewers which already exist along the line of the new intercepting sewer. A case of this kind was illustrated in connection with the article on the 12th St. and 22d St. intercepting sewers in our issue of Feb. 24, and the present work furnishes many other examples. Fig. 4 shows the construction of the masonry retaining wall at the outfall. This will be built within a cofferdam. The design of the wall and the portal is simple, but of good appearance, and the coping will be surmounted by a wrought iron fence 3 ft. 6 ins. high.

Methods of Construction.

The specifications, as drawn up by Mr. F. E. Davidson, Superintendent of Sewers, include some interesting features. They call for bids for a price per lin. ft. on each part of the tunnel work, open cut work, and each piece of sewer connection, the price in each case covering every kind and sort of work on that section, including the shoring and protection of buildings, streets, railway tracks, etc., whether shown on the plans of not. For extra work "ordered in writing by the engineer, but not specified or shown in the plans," the following prices will be paid; brick masonry, $7 per cu. cu. yd.; foundation timber, sheeting and planking left in place, $15 per M., B. M., for pine and $25 for oak; reconnecting extra house drains (beyond the number specified), $3 and $3.50 each for 6-in. and 9-in. drains; reconnecting extra catchbasins, $5 each. Work on the tunnels is to be carried on continually, by day and night and on Sundays, from two headings at each of the three shafts on each tunnel. All the work must be guaranteed for one year, the contractor making all repairs required within that time, and 5% of the contract price being withheld until the expiration of the guarantee. The profiles show the materials met with in test borings, but the city does not warrant these as being even approximately correct, and no extra allowance will be made for changes in the character of the supposed soil, the contractor assuming all risks, whether clay, quicksand, boulders or other materials are met with. In the tunnel work, the compressed air system will be used, with a shield in each heading, but it is not probable that the character of the material will allow of any but a light pressure being carried.

Various plans for iron and wood linings for the outside of the conduit have been considered. One of the plans suggested by Mr. Davidson as a possible method of construction for the 20-ft. conduit, proposes five brick rings, making a shell 1 ft. 10 ins. thick, and a 6-in. outside ring formed of wooden pieces or blocks 2 × 6 × 24 ins., cut to shape to fit the circular brick shell, and well spiked together. As the work will all be in wet clay this timber shell would last indefinitely. In the abstract of the specifications, given below, will be found a clause referring to such alternative plans.

The following is an abstract of the more important portions of the specifications for the main conduits on Lawrence Ave. and 39th St.:

Bricks.—The sewers are to be of sound and hard burned bricks, of compact texture, 8 × 4 × 2¼ ins. in size. When thoroughly dried and then immersed in water for 24 hours, they must not absorb more than 10% of water.

Pipe.—Sewer pipe must be smooth and sound, thoroughly burned and vitrified, and well glazed. The standard thickness is to be ¾-in. for 9-in. pipe, 1 in. for 12-in., 1¼ ins. for 15-in., and 1½ ins. for 18-in. pipe. Butt joints are to be used, each piece having a sleeve or ring 4 ins. wide and with an inside diameter not less than 2 ins. greater than the external diameter of the pipes. All slant junctions are to be molded for an angle of 34° with the sewer with which they connect.

Cement.—All cement used in brick and stone masonry and in pipe laying must be of the best quality of American natural cement, fresh ground; 80% must pass a sieve of 80 meshes per lin. in., and briquettes gaged neat must show a tensile strength of 120 lbs. per sq. in. in 7 days (1 in air and 6 in water). The reputation of the cement must have been established by use by the Department of Public Works.

All cement used in concrete work must be American or German Portland cement, of reputation known and established by use; 93% must pass a standard sieve of 10,000 holes per sq. in., and a mixture of 1 part cement to 3 parts sand must show a tensile strength of 165 lbs. per sq. in. in 7 days (1 day in air and 6 days in water), with an increase in strength of not less than 33% at the end of 28 days and an additional increase of 15% at the end of three months. As ample time is allowed, the contractor must submit samples of the Portland cement he desires to use, and three to five brands may be approved by the engineer, any of which the contractor may use, subject to daily tests. The contractor must furnish storage and keep at least one month's supply on the work at all times.

Broken Stone.—The broken stone for concrete work must be sound limestone, the largest pieces of which must pass a 1½-in. ring and graduated in size so that the voids shall not exceed 30%. It must be free from dust, or screenings, dirt or clay; quarry strippings will not be accepted.

Concrete.—Concrete must be composed of 1 part cement, 3 parts sand and 8 parts broken stone, the stone being wet or washed before the mortar is spread. The cement and sand must be measured and thoroughly mixed dry until of a uniform color, and then wet through a rose head with as little water as will render it proper for use and thoroughly worked. The stone shall be measured and spread about 4 ins. thick on a tight board platform; the mortar shall be spread evenly on the stone, and the whole shall be turned in place with shovels without heaping until each stone is thoroughly coated with mortar.

The concrete shall be quickly and carefully deposited in place, without throwing, and spread in layers not more than 6 ins. thick, and rammed with iron rammers until water shows on top.

All exposed surfaces of concrete, and the back of the retaining wall, shall be plastered with Portland cement mortar made of 2 parts cement and 3 parts sand, not more than ¾-in. thick, applied before the concrete has set hard, floated to a straight edge, and troweled smooth.

Mortar.—All mortar for brick and stone masonry shall be made by carefully measuring and mixing (until of a uniform color), 1 part of natural cement with 1 part of sand; a moderate quantity of clean water is to be afterwards added to produce a paste of the proper consistency, the whole to be quickly and thoroughly worked with hoes or other tools. Mortar shall be mixed in such quantities as to allow it to be used immediately after being mixed, and the use of mortar which has been set and then retempered will not be allowed.

Excavation in Tunnel.—On each section, tunneling shall be carried on from three working shafts. From each shaft a heading shall be driven each way, making six headings on each section, at each of which work shall be carried on continuously, day, night and Sunday. Each heading shall be protected by a shield of approved construction, and the masonry shall be built and keyed within this shield before moving it ahead. Compressed air shall be used and maintained at proper pressure at each heading, to prevent inflow of earth or water.

The work shall be carried on in such a manner as not to disturb the superincumbent earth or remove water from the foundation of adjacent buildings. The contractor shall make good any damage which may occur to neighboring properties through his negligence, carelessness or unskillfulness in the prosecution of this work.

The excavation of all tunnels shall conform exactly to the outside diameter of the brick masonry, and the contractor shall not be allowed to excavate, even in good ground, more than can be lined with brick masonry in one shift. In all cases where, for any reason, the excavation or opening through which the tunnel is to be con-

structed shall be larger than the outer diameter of the brick masonry, or naturally becomes larger through the encountering of rock, silt, quicksand, or otherwise, the entire excavated, open or hollow space outside of the regular tunnel masonry shall be filled with solid brick masonry or other material, as directed by the engineer, by the contractor, at his own expense, as a part of the contract work. No extra allowance will be made for quicksand or hard pan. For all rock excavation, in addition to his price per lin. ft. for conduit or sewer, the contractor shall receive a compensation of $2 per cu. yd.; boulders of ½-cu. yd., or over, in size, will be measured as rock excavation.

No blasting shall be allowed in the tunnel except by special permission, and should such permission be granted then the contractor is to use only such charges and such grades of powder or explosives as determined by the engineer, and shall be responsible for any and all damages that may be occasioned by the use of same.

The contractor shall use electricity for lighting the tunnel and shall keep the tunnel free from smoke and noxious gases, in order to enable the workmen and inspectors to properly and safely perform their duties, and also to permit the engineers to establish the alinement of the tunnel and do other engineering work efficiently.

Shafts.—Walls for all shafts shall be of the same thickness as walls for conduit or sewer of same dimensions. The eyes or openings for the tunnel shall be neatly groined. Where required, there shall be built into the masonry of the shaft wrought iron steps to form a ladder from top to bottom, but no extra allowance shall be made for such iron steps used in constructing the shaft. The sumps at the bottom of the shafts shall be 5 ft. below the bottom of the tunnel work and shall terminate with an inverted arch with 1-ft. rise. After the completion of the tunnel work the sumps shall be filled with brick masonry or concrete to a line level with the bottom of the tunnel.

A cage must be used for hoisting men and material during the construction of the tunnel and full precaution must be taken to ensure perfect safety. Safety catches of tested efficiency and strength must be used in connection with the cages to hold them in case of accident.

After the completion of the tunnel, all temporary shafts shall be properly domed with six rings of brick work just above the arch of the tunnel, and on the dome shall be placed solid brick work filling, of the entire area of the shaft for a height of 6 ft.; the balance of shaft shall be filled with clay or other suitable material. All permanent shafts must be covered with I-beams and concrete, with manholes built to surface of street.

Excavation in Open Cut.—All trenches must be sheeted and provision made to keep all work dry during construction, and all water shall be removed by pumping or bailing or otherwise. The trenches must be of sufficient width to admit of ample room within the lines of sheeting to permit of the work being constructed in the manner and size specified. In wet trenches the width of the trenches inside the sheeting is to be 3 ft. greater than the outside diameter of the work, and for 12-in. and 15-in. pipe sewers, wet sheeted trenches shall not be less than 5 ft. in width.

Whenever the nature of the ground will admit of it, the bottom of the excavation is to have the shape and dimensions of the outside of the lower half of the conduit or sewer. In order to secure this, the contractor shall provide a pattern or form made with two segments, one to fit the outside and the other the inside of the invert. It is to be firmly and securely set to the proper grade, by the stakes given by the engineer, and is to remain unmoved in its position until after the masonry is laid. The bed of the conduit or sewer shall then be brought to the required shape by trimming, with suitable tools, to a line stretched from the outside of the masonry or concrete to the form.

If the character of the ground met with in excavating is such that the external form of the conduit or sewer cannot be preserved, the excavation shall be made to conform thereto as nearly as possible, and the space between the external conduit or sewer lines and the bottom and sides of the excavation so made, for a width equal to the outside horizontal diameter of the conduit or sewer at the springing line, shall be filled with brick masonry or concrete by the contractor, who will be paid for same. The excavation of the trench shall not advance more than 200 ft. ahead of the completed masonry or pipe work.

Protection Against Water.—On Section C, the contractor shall provide at or near Wallace St. a sufficient pumping plant and outlet or temporary outlet to dispose of not less than 40,000 gallons per minute. On Section D, east of Beacon St., a similar plant or outlet to dispose of not less than 25,000 gallons per minute shall be provided. The contractor shall operate and maintain these plants at his own expense until the completion of this contract.

If the conduit specified is not put in operation immediately upon completion, the plants or outlets shall be temporarily placed in control of the city, and upon the operation of the conduit shall revert to the contractor, who shall remove same, restoring the street as herein provided.

There is no outlet on any work included in this specification, and the contractor shall remove all water by pumping or bailing, and shall build all drains and do all other work necessary to keep the trench and masonry work or concrete work clear of ground water, sewage, or storm water during the progress of the work, and until the cement mortar is sufficiently set to be free from injury.

In wet trenches he is to keep a channel open on each side of the work during its construction, which shall be so maintained as to catch the water from the sides of the trench and to conduct it to a sufficient pump or bail-hole in front of the work.

Back Filling.—After the arching is completed on any length of conduit or sewer, and before the centers are struck, the trench is to be filled to a height of not less than 2 ft. above the arch. On brick conduits or sewers, the spandrels are to be well consolidated to a height of 6 ins. above the crown of the arch by thoroughly ramming wherever the ground is of a nature to admit of it. As soon as the mortar and masonry are sufficiently set, the trench is to be filled to prevent liability of injury to the banks, road surfaces, adjacent property, railway tracks, sidewalks, or other property, public or private.

In all streets or parts of streets that are paved, graveled, macadamized, cindered, planked or covered with any material other than the natural ground, all the back-filling is to be well rammed with suitable tools in layers not exceeding 6 ins. in depth, providing it is clay, stiff loam, or any variety of a tenacious nature. If the ground is sand or gravel, the back-filling is to be puddled in such a manner as directed by the engineer. After being puddled or rammed to the required height as specified, the paving or other material shall be carefully and thoroughly relaid in a manner adapted to the peculiar character in each case.

The surplus material taken from the trench is to be removed entirely from the street, or disposed of in such a manner as directed by the engineer, so as to save the city free from all damages or expense on account thereof. The back-filling shall in all cases be left with a smooth and even surface. Where required, the back-filing shall not be left unfinished more than 200 ft. behind the completed work.

Manholes.—All manholes are to be circular in section and 3 ft. internal diameter; they are to be built with two rings of brick, laid as specified, giving a thickness of 8 ins. to the wall. On unpaved streets the tops of the manholes are to be 4 ins. lower than the surface of the street; on paved streets 1 in. lower.

The top courses of bricks in each manhole are in all cases to be made of whole bricks, laid as headers. The tops of all manholes are to be 2 ft. in internal diameter, being drawn in by header courses, laid horizontally, the diameter being decreased 1 in. for each course. On sewers less than 3 ft. in diameter the manholes are to have solid masonry or concrete foundations laid 12 ins. below the grade of the sewer.

Catchbasins.—All catchbasins shall be 4 ft. internal diameter, built of two shells or rings of brick, upon a floor of 6 ins. of concrete, with 9-in. half-trap, and connected to the sewer with 9-in. pipe; the brick work shall be 7 ft. 2 ins. deep, the bottom of the outlet pipe to be set 3½ ft. above the bottom of the brick work. The top of the cover to be set 8 ins. below the grade of the street, and when directed by the engineer the contractor shall leave an inlet to the basin on the side next to the curb, under the cover, to receive the water from the gutters, 8 ins. wide and 12 ins. deep.

Covers.—All covers for manholes and catchbasins shall be of good quality of cast iron. A curb and lid shall weigh not less than 470 lbs., and shall be the same size and pattern as iron covers now in use by the Bureau of Sewers.

Foundations.—Whenever the ground is sufficiently firm and unyielding, the masonry or pipes are to be laid directly on the bottom of the excavation; but whenever this shall not be the case, and such foundation is not shown on the plan, it shall be built of masonry, concrete, or of pine plank and timber, as the engineer may direct. The contractor will be allowed extra compensation for this work at the prices specified in the contract for the different kinds of foundation required, except where the invert has been taken out below the proper depth or wider than necessary, or a sliding or caving-in of the sides of the trench has rendered the bottom or sides of the trench unstable, or where a subdrain has been ordered; in every such case the foundation and sides of the trench shall be brought to the proper size and form with broken stone, concrete, brick work, or stone masonry, by and at the expense of the contractor.

Brick Masonry.—The conduits and sewers shall be built with brick masonry of the following thickness: 20-ft. conduit in Thirty-ninth St., six rings or shells of brick; 16-ft. conduit in Lawrence Ave., five rings or shells of brick. In case the contractor wishes to use an outer shell or ring of wood or iron he must submit plans for the same to the engineer in charge, and if plans are approved by the engineer, the conduits may be built with one shell or ring of brick less than specified above, but contract price for same shall be neither increased or diminished.

All brick sewers 2½ ft. in diameter and less are to be built with one shell or ring of brick; all brick sewers 6 ft. in diameter and over 2½ ft. in diameter are to be built with two shells or rings of brick, and all over 6 ft. and under 9½ ft. in diameter are to be built with three shells or rings of brick.

The brick must be clean and thoroughly wet before being laid, the most perfectly formed and those with the

MAP OF BOSTON, MASS., SHOWING PROPOSED ROUTE OF NEW ELEVATED RAILWAY AND ITS CONNECTIONS WITH THE RAPID TRANSIT SUBWAY AND THE SURFACE STREET RAILWAYS.

smoothest surfaces are to be used in the inside courses, the smoothest edge being laid to the face. The courses in conduits or sewers are to be laid to line, and kept perfectly straight in the direction of the conduit or sewer, and parallel to the rise of the same, and shall be laid as stretchers, breaking joints with those in the adjacent courses.

In shafts, the courses shall be horizontal, laid stretchers to vertical lines drawn from top and bottom forms. In manholes and catchbasins the inner ring shall be of vertical brick and the outer may be of bats; joints to be broken in all work.

Every brick must be separately laid in full mortar joints on bottom, side and end, which for each brick must be formed by one operation; in no case is the joint to be made by grouting, or by working in the mortar after laying the brick. No joints shall exceed ½-in. in thickness, and all joints on the face shall be trowel struck. All brick work on conduits and sewers in open cut as it progresses must be raked back in courses, and in no case will it be allowed to be toothed, except by permission of the engineer.

General.—The conduit and sewers after completion must be left entirely clear of rubbish and dirt of every kind and description, and dead ends are to be carefully closed with brick masonry, so as to exclude all running sand or other material.

The contractor shall furnish all necessary facilities, should it be deemed advisable by the engineer, to make an examination of any work already completed. If the work is found defective in any respect, the contractor shall defray the expense of such examination and of satisfactory reconstruction. If the work is perfect, such expense will be allowed for. No extra or customary measurements of any kind will be allowed in measuring the work under these specifications; but the actual length, area, solid contents, or number shall be considered, and the length shall be measured on the center line of the work, whether straight or curved.

No work in masonry shall be done when the thermometer is below 35° F., without written permission from the engineer, and then under conditions for protecting it from frost approved by him.

Monthly estimates will be made by the Commissioner of Public Works of the value of the work actually constructed and in its permanent place; and on or about the 6th day of each month vouchers for 85% of the estimated value of the work done the previous month will be issued, the remaining 15% to be reserved until the completion and acceptance of the whole work, at which time two-thirds of the said 15% shall be paid to the contractor, and the remaining one-third retained for one year to secure restoration of streets, repairs to conduits or sewers, etc. The Council Ordinance of March 15, 1896, relating to eight hours constituting a day's work, shall be observed in this contract.

PROPOSED ROUTE OF THE BOSTON ELEVATED RAILWAY.

The accompanying map shows the route of the proposed elevated railway, which has been submitted to the Board of Railroad Commissioners of Massachusetts for approval by the Boston Elevated Ry. Co. This company was incorporated in 1894, and in 1897 the Massachusetts State Legislature amended the original act by giving to the company additional powers and locations. As the law now stands the company has the following powers:

(1) To construct lines of elevated railway to be operated by electricity or other motive power except steam, according to such routes and plans as the State Board of Railroad Commissioners may approve.

(2) To have the Boston Transit Commission, upon compliance by the railway company with certain requirements, construct a subway under or near Cambridge St., and under Bowdin Square and Court St. to connect with the subway now being constructed; also to construct a tunnel or tunnels of sufficient size for two railway tracks from a point on or near Hanover St., or such other point as the Commission may deem proper for suitable connection with the subway, to a point at or near Maverick Square, in East Boston, where a suitable connection with the surface tracks may be made. Finally, the Transit Commission is to lease this new subway and tunnel line to the Boston Elevated Ry. Co., for 25 years, at an annual rental of ⅜% of the gross receipts of all lines owned, leased or controlled by the railway company.

(3) To lease and operate the lines, property, etc., of the West End Street Ry. Co., and other street privileges. The lease of the West End St. Ry. Co has already been made.

It will be seen from the foregoing that the Boston Elevated Ry. Co., upon compliance with certain requirements, will control, besides its own elevated lines, all of the vast network of street railway lines formerly controlled by the West End Street Ry. Co.; the rapid transit subway already built, and additional subway and tunnel lines ordered to be built in the future, and also possess a free field to buy or lease any other street and elevated lines it may desire, subject to the approval of the Board of Railroad Commissioners. Some idea of the great extent of this transit system may be obtained by examining the accompanying map, on which are shown all the lines of the West End Street Ry. Co., the route of the new subway now nearly completed, and the proposed route of the elevated line proper.

Turning now to the elevated line which is at present proposed, it will be seen that it runs from Roxbury north to Charlestown, forming with the subway, with each end of which it connects by a span line, a complete loop enclosing the principal business section of Boston. The total length of the line between terminals, not including any of the subway, is about seven miles. Along this distance there will be eleven stations, located as shown on the map, at distances from each other varying from 0.2 mile to 1.08 miles, or an average distance of 0.56 mile. Two types of structures are proposed, known as the arched and truss, and these will also differ in narrow and wide streets. In the narrow streets the supporting columns will be placed on the curb lines, and in the wide streets the columns will be placed in the street just far enough apart to allow the surface car tracks to run between them. According to the estimates, the construction, exclusive of stations, will cost about $400,000 per mile, or $2,800,000 for the entire seven miles. It is estimated that the stations and equipment will raise the total cost to $5,000,000. The third rail system of electric traction will be used.

The law incorporating the elevated railway company, as amended, provides that the fare charged shall not exceed "five cents for a single continuous passage in the same general direction upon the roads owned, leased or operated by it," and therefore the terminal stations at Roxbury and Charlestown are made transfer stations at which passengers can be transferred from the surface to the elevated lines, and vice versa. This is accomplished by running the surface cars into the elevated stations by means of inclines. At each of these stations also there will be loop lines for transferring the elevated railway trains from the incoming to the outgoing tracks. Access between the subway tracks and the elevated lines is obtained by inclines constructed on a grade of 5%. Special means of access are also provided between the elevated line and the various steam railway stations along its route.

In closing it may be noted that the route shown on the accompanying map is for that portion of the elevated line in Boston proper. The South Boston, East Boston and Cambridge lines are to be decided upon later. It is expected that the position of the line now proposed will require about a year for construction after the contracts are let, which, it is stated, will be as soon as practicable after the route is formally approved by the Board of Railroad Commissioners. The money for construction is said to be all secured.

AN INSTRUMENT FOR INDICATING THE CONDITION OF STORAGE BATTERIES.

The illustration given herewith represents a form of watt-meter intended to prolong the life of storage batteries, whether used for motor carriages, street cars or electric launches, by warning the operator of the condition of the battery and thus prevent discharging below the safe limit.

The essential requirements for a battery indicator or meter is that its armature shall rotate in either direction, giving accurate readings in both cases. In this instrument the energy put into the cells when charging is added to the meter reading, and that withdrawn during discharging is subtracted. To compensate for the various losses in the battery the meter operates at a slower speed while charging is going on. The readings are arranged to indicate the available amount of energy at any given instant, the needle pointing to every case the meters are made to order, except zero when the battery is discharged. As the ratio of charging to discharging rate varies in almost

A Storage Battery Indicator.
General Electric Co., Schenectady, N. Y., Makers.

for a 50-ampere type, which may be considered as standard and is kept in stock.

The instrument is manufactured by the General Electric Co., of Schenectady, N. Y.

TIN PLATE MANUFACTURE IN THE UNITED STATES

The steady development of the American tin plate industry is indicated in the quarterly list of tin plate works printed by "The Metal Worker." The list gives all the effective tin plate mills and dipping plants, with the brands of tin and terne plates made by each, the information being corrected to April 1.

There are at present 65 completed plants engaged in the manufacture of tin and terne plates, or producing black plate for tinning purposes. Of these, 42 are tin plate works proper, rolling their own black plate, 37 of which are also tinning and finishing their product. Five plants are as yet unprovided with tinning facilities, and dispose of their black plate mainly to the dipping works. These 42 black plate plants possess 237 complete hot mills, and seven of them are adding to their equipment a total of 33 new hot mills. In addition, two new black plate plants, with an aggregate of 32 hot mills, are in course of erection, making a grand total of 302 hot mills in 44 separate plants, operated by 41 firms, as against 291 hot mills, built and building, in 46 separate plants on Jan. 1.

Of the 42 completed black plate plants, only one, a three-mill plant, was reported as shut down at the end of the quarter. The temporary idleness, for various reasons, of about 12 other hot mills at various works, mostly owing to transient causes, leave a total of 222 mills in active operation on April 1. This is the largest capacity ever employed in the history of the American tin plate industry, representing a current output at the rate of fully 5,500,000 boxes of tin plate a year, with a potential capacity for the finished mills (if they were all in operation to their extreme capacity) of about 6,000,000 boxes annually.

The number of dipping works included in the present list is 23, as compared with 28 shown in the last list. The reduction in the number of these plants is due to four plants which manufacture bright plate solely for their own use having been omitted, as their output does not figure in the market. One dipping concern, having ceased to manufacture tin plate has also been dropped. The dipperies have been running very light in the past quarter. Of the 120 tinning sets possessed by these works, probably but from 25 to 50 per cent. have been kept in operation, while three or four of the works have been shut down entirely.

The erection of no new tin plate plants was begun during the quarter, but two have been transferred from the "building" to the "completed" list.

SPECIFICATIONS FOR AIR BRAKE AND SIGNAL HOSE; LAKE SHORE & MICHIGAN SOUTHERN RY. CO.*

1. All air brake and signal hose must be soft and pliable, and not less than two-ply or more than three-ply. They must be made of rubber and cotton fabric, each the best of its kind made for the purpose. No rubber substitutes, reclaimed or old rubber stock or short fiber cotton to be used.

2. The tube must be hand-made, composed of three calendars of 1-32-in. rubber; it must be free from holes, or imperfections in joining, and must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting the tube. The tube must be made of high quality of rubber, and must be of such composition as successfully to meet the requirements of the stretching test given below. The tube must not be less than 3-32-in. thick at any point. It may preferably be made in composite form, with a complete inner tube of 1-16-in. rubber wrapped with a single wrapping of 8-oz. cotton canvas, the whole being covered with an outer tube of 1-32-in. thick rubber.

3. The canvas or woven fabric used as wrapping for the hose to be made of long fiber cotton, loosely woven, and to weigh not less than 22 ozs. per yd., and to be from 38 to 40 ins. wide, except when woven with a seamless tubing. The wrapping must be frictioned on both sides, and must have in addition a distinct coating or layer of gum between each ply wrapping not less than 1-32-in. thick. The friction and coating must be of the same quality of gum as the tube. The canvas wrapping to be applied on the bias.

4. The cover must be of the same quality of gum as the tube, and must not be less than 1-16-in. thick. The cover may preferably be made in composite form in the same manner as provided for with the rubber tube. In this case there must be not less than 1-32-in. thickness of rubber between the outer ply of wrapping and the 8-oz. duck forming part of the cover, and there must be an equal thickness of rubber on the outside.

5. Air brake and signal hose are to be furnished in 22-in. lengths. Variations exceeding ¼-in. in the length will not be permitted. The inside diameter of all such hose to be not less than 1¼ ins. nor mare than 1 5-16 ins., except on the ends, which are to be enlarged to 1 7-16 ins. for a distance of 2¾ ins., the change from larger to smaller diameter to be made tapering, so that inside of hose will be perfectly smooth. The outside diameter must not exceed 2 ins., nor be less than 1⅞ ins. in the main part, or exceed 2 3-16 ins., or be less than 2 1-16 ins. at the enlarged ends. Hose must be finished smooth and be regular in size throughout as above indicated, ends of hose to be capped with from 1-16 to ⅛-in. of rubber. Caps must be vulcanized on, not pasted or cemented.

6. Each standard length of hose must be branded with the name of manufacturer, year and month when made, and the standard, L. S. & M. S. Ry. mark, and also have a table of raised letters at least 3-16-in. high, to show date of application and removal, thus:

97 } A { 1	2	3	4	5	6
98 } A { 7	8	9	10	11	12
99	.....						
00 } R { 1	2	3	4	5	6
01 } R { 7	8	9	10	11	12

All markings except the road mark may be combined in one plate. All markings to be full and distinct, and made on a thin layer of white or red rubber vulcanized on, and so applied as to be removable only by cutting with a knife or sharp instrument.

7. Air brake and signal hose will be subjected to the following tests:

Each hose must stand a proof pressure test of 300 lbs. without failure of any kind. With every lot of 200 or less shipped to one point, the manufacturer must furnish free of charge one additional hose for test. From each such lot one hose will be taken at random, and subjected to the following tests in the order named:

Bursting Test.—The test hose must stand a pressure of 500 lbs. before bursting.

Friction Test.—A section 1 in. long will be taken from any part of the hose, and the friction determined by the force, and time required to unwind the hose; the force being applied at right angles to the line of separation. With a weight of 25 lbs. suspended from the separated end the separation must be uniform and regular, and when unwinding the average speed must not exceed 6 ins. in 10 minutes.

Stretching Test.—A 1-in. section of the ruber tube or inner lining will be cut at the lap or thickest part. Marks 2 ins. apart will be placed on it. The 1-in. strip will next be stretched until the marks are 10 ins. apart, and then released immediately. The piece will then be remarked as at first, and stretched to 10 ins., or 400%, and will remain stretched 10 minutes. It will then be released and the distance between the marks measured 10 minutes after the release. In no case must the test-piece break from defective quality of rubber, or show a permanent set of more than ¼-in. between the 2-in. marks. Small strips taken from the cover or friction will be subject to the same test.

8. If test hose fails to stand the required tests, the lot from which they are taken will be rejected without further examination. If test-hose are satisfactory, the entire lot will be examined, and those complying with the requirements herein set forth will be accepted. All rejected hose will be returned, the shipper paying freight charges both ways.

A. M. Waitt,
General Master Car Builder.

Cleveland, O., Aug. 1. 1897.

*From a committee report at the March meeting of the Central Ry. Club.

BOOK REVIEWS.

SEWER GAS AND ITS INFLUENCE ON HEALTH.—By H. Alfred Roechling, Assoc. M. Inst. C. E.; Fellow of the Royal Statistical Society, etc., etc. London: Biggs & Co., Salisbury Court, Fleet St., E. C. Cloth; 5½ + 8¾ ins.; pp. 224; tables and diagrams. Price: London, 5s.; New York, $2.

This is a good discussion of the subject named in the title. The author has consulted many papers and articles relating to sewer gas, and in a series of appendices makes numerous citations from his authorities. He also gives an extensive bibliography of the subject. His conclusions are that it has not been proven that disease germs are transmitted by sewer air, or if so only in small numbers and infrequently. Nevertheless, he is strongly of the opinion that sewer air has a causal relation to typhoid fever, and possibly to other zymotic diseases. Just what this relation is he does not clearly set forth, except it be by the statement that the breathing of sewer gas is a predisposing cause of typhoid.

We do not doubt that sewer air is a predisposing cause of zymotic diseases. That it is more so than any other form of impure air, or any other cause of general poor health that puts the human system in such a condition as to make a person unfit to resist infection needs further proof before we can accept it as an established fact. But notwithstanding this there are ample reasons for insisting upon such means of removing human wastes from our houses as shall make the admission of the gases of decomposition impossible. This is first to be secured by so establishing and maintaining our sewerage systems that the generation of harmful gases within them is reduced to a minimum, and next by making our plumbing so perfect that sewer air cannot gain access to our houses. If this was always done, and our water and milk supplies were protected to the utmost from infection by human excreta, typhoid fever would soon be well nigh stamped out and some other zymotic diseases would be wonderfully lessened, especially diphtheria and scarlet fever, which are easily and often disseminated in milk. The effect of excluding sewer air from our homes we should consider to be more especially upon the general health, lessening troubles in the digestive system and giving better tone to the blood, thus enobling the system to refuse foothold to disease germs of whatever kind, however admitted. The effect of pure water and milk supplies would be to lessen marvellously the number of disease germs that gain access to the human body.

We have no doubt but what Mr. Roechling will agree with us in the main in the above opinions, except that he appears to go further than we do in considering sewer air as a predisposing cause to one specific form of disease, typhoid fever.

We wish that he had given more information regarding the changes in the water and milk supplies, in connection with his citations of typhoid cases attributed to sewer gas, and of the reduction in typhoid mortality which has followed the introduction of sewerage systems in many localities. Shallow private wells are continued in use, in this country at least, long after public water supplies are introduced. They are believed to be one of the most fruitful sources of typhoid fever, owing to their nearness to leaching cesspools and privy vaults. Water carriage sewerage systems follow after the introduction of public water supplies, and the use of the latter is always greatly increased after sewerage systems are introduced, both by the laying of water mains on streets not previously supplied and by the introduction of water to houses previously depending on shallow private wells, although the public water mains were already in the street. This stimulus to the use of the public water supply leads to the abandonment of scores and hundreds of polluted wells. In addition, the sewerage system gradually improves the quality of the water in such wells as remain in use, since with the introduction of the sewers the use of cesspools and privy vaults is stopped, and with it the pollution of the wells immediately begins to diminish. In such cases the diminution of typhoid bacilli in the well water is doubtless far more rapid than the improvement in the chemical composition of the water, so that the danger from polluted well water after the cesspools are abandoned decreases more rapidly than does the contamination of the soil from organic matter. From the above it follows that the decrease in typhoid fever sometimes noticed after the introduction of sewers may be largely due to a simultaneous improvement in the quality of the water consumed by the population along the sewers.

Mr. Roechling cites some inspections of plumbing in his own town of Leicester, England, and elsewhere, which showed that from 25 to 45% of the houses in which typhoid fever had occurred were provided with plumbing that allowed sewer air to enter the living rooms. But in what percentage of the remaining houses in these towns did the same defective plumbing exist?

The questions we have raised regarding this book are not intended to belittle its value, but only to suggest other lines of inquiry. Mr. Roechling gives no indication of being wedded to any theory. What he wishes, if we rightly grasp the spirit of his book, is to stop the spread of disease, and he is considering only one phase of the relation of sewage to health, the effect of the gases incident to the decomposition of sewage. As such a study we commend the book to our readers, with the caution that so much attention should not be given to sewer air as to detract from the other hygienic phases of sewerage construction and maintenance.

COMMISSIONER OF PUBLIC ROADS OF NEW JERSEY. Fourth Annual Report; for the Year Ending Oct. 31, 1897; Trenton, N. J. Paper, 9 × 6 ins.; pp. 128; illustrated.

Under the State Aid Law of 1892 and 1895, for the construction of public roads, New Jersey has expended between 1892 and 1897, inclusive, $466,595. This is on the basis of the payment by the state of not more than $100,000 per annum for one-third of the cost of construction, the other two-thirds being furnished by the counties and property-holders benefited. Under the law the estimated cost of all improvements, together with the estimated cost of repairs on roads already built in any county in any one year, must not exceed ¼% of the rateable tax for such county for the last preceding year. All road taxes are paid in money; the old office of overseer of highway is abolished, and the roads of a township are placed in the hands of the township committee and money is raised by township bonds issued for this purpose. Under the County Act, the Board of Chosen Freeholders designate certain roads as county roads, and improve them by the issue of county bonds. Under the State Aid Law, whenever the owners of two-thirds of the lands fronting on any public road will undertake to pay one-tenth of the cost of improvement, the Board of Chosen Freeholders may order such improvement, and the State will pay one-third of the cost, up to the present limit of $100,000 per year for all road improvement in the state.

In the present report Mr. Henry I. Budd, the State Commissioner of Public Roads, gives the detail of this state work for the last year, and adds much valuable matter pertaining to road construction. He says that whereas these roads formerly cost from $6,000 to $9,000 per mile, the average cost per mile has now been reduced to $3,000 to $4,000, with the wearing qualities as great, if not greater than before. The former opposition to the law has changed to a demand for improvement greater than the present appropriation of $100,000 per annum will meet. During last year, about 70 miles of new macadam road were built at a cost of $350,000 to the state, counties and individuals; and much more than this was really expended by the latter parties in widening roads, etc., as the state only aids in building roads 16 ft. wide in cities and 12 ft. wide in the country, with the purpose of spreading the money over as great a distance as possible. Mr. Budd says that if the state should ever spend $300,000 per annum, over $1,000,000 per year would be expended upon road building, and thus rapidly make the state one of the most desirable in the Union for residence and business.

Mr. Budd insists upon wide tires as a necessity in the maintenance of good roads. In France tires range in width from 3 to 10 ins., and as the forward axle of every market and heavy wagon is 14 ins. shorter than the rear axle, every wagon is an efficient roller. In Germany and Austria, similar laws prevail, and in our own country the State of Michigan allows a rebate of one-fourth of the road tax for wide tires. The states of New York, California, Ohio, Indiana, Kentucky, Vermont, Pennsylvania, Rhode Island, Massachusetts and Connecticut have laws pertaining to the width of tires, more or less efficiently enforced. New Jersey passed such a law in 1897, but it was vetoed by the Governor because it applied to cities as well as to rural communities.

As showing the advantages of wide tires, the Commissioner makes the following general statement: You can haul 505 lbs. more, with the same power exerted, on a 4-in. tire on good, hard, sandy roads, than with a 1½-in. tire. On a level gravel road, the 4-in. tire will handle 471 lbs. more than the 1½-in. tire, with the same exertion of power. Broad tires act as rollers and benefit the roads by compacting them and preventing ruts. He gives the text of the New Jersey wide-tire law referred to, and also of the Rhode Island law, passed in May, 1897.

The report follows with suggestions as to the characteristics of "Macadam as it should be;" as to best methods in road building; trap rocks for roads; the essential qualities of road-stones, and the effects of moisture on a roadway. The report also includes instruction to supervisors, notes on steel rails for highway purposes, motor-cars on common roads, etc. The various engineers and supervisors give detailed reports of cost for the roads built in New Jersey in the last year, and in the appendices are the full specifications for macadam and telford construction, under the State Aid Law, the specifications for gravel roads, and the text of the State Aid Law itself. A table interesting to builders of stone roads is one giving the square yards in one mile of stone road for widths, varying by 2 ft., from 8 ft. to 18 ft. inclusive; and another series of tables gives the cost of one mile of road, of the several widths mentioned, at from 25 cts. to $1 per sq. yd., by increments of 5 cts.